National Patterns of R&D Resources: 1996

An SRS Special Report

Division of Science Resources Studies
Directorate for Social, Behavioral and Economic Sciences

National Science Foundation

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Steven Payson and John E. Jankowski, Jr.

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NOTE

Data in this report are current as of July 1996. These data are more current (reflecting updates and revisions) than data on the same variables provided in *Science and Engineering Indicators, 1996*, which had been released in January 1996.

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Contributors

Data preparation and analysis were performed by Steven Payson and John E. Jankowski, Jr., of the Division of Science Resources Studies.

FOREWORD

In monitoring the resources used in U.S. science and technology, the National Science Foundation assembles and analyzes information about the money and people devoted to research and development and compares U.S. performance with the efforts underway around the globe. Since 1956 we have been issuing reports that summarize national trends. These reports complement the National Science Board's *Science & Engineering Indicators* volumes, which have been published biennially since 1972, and provide an overview of material presented in several other reports issued by the Division of Science Resources Studies.

Jeanne E. Griffith
Director, Division of Science Resources Studies
Directorate for Social, Behavioral and Economic Sciences

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ABBREVIATIONS

DOD	Department of Defense
DOE	Department of Energy
FFRDC	federally funded research and development center
FTE	full-time equivalent
FY	fiscal year
GDP	gross domestic product
GSP	gross state product
HHS	Department of Health and Human Services
IRI	Industrial Research Institute
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NSF	National Science Foundation
OPM	Office of Personnel Management
PPP	purchasing power parity
R&D	research and development
SIC	Standard Industrial Classification
SSA	Social Security Administration
S&Es	scientists and engineers

General Notes

The National Science Foundation (NSF) sponsors a series of surveys to collect information on the financial and human resources devoted to research and development (R&D). In this report, NSF survey data on the various sectors of the U.S. economy—industry, Government, academia, and selected nonprofit organizations—are aggregated so that the components of the overall R&D effort are placed in a national context. Information presented in *National Patterns* includes the following:

- the level of R&D expenditures;
- the sources of such funds;
- the sector or organization performing the R&D;
- the character of work undertaken (i.e., whether it is basic research, applied research, or development);
- the States in which R&D is undertaken in the United States;
- the number of scientists and engineers employed in R&D; and
- international comparisons with the U.S. effort.

The national totals reported here incorporate data available from several Division of Science Resources Studies (SRS) surveys as of July 1, 1996, with projections to cover the remainder of the year 1996.

These notes provide a brief introduction to the concepts used in the report. Significant deviations from previous *National Patterns* reports are also highlighted. For complete definitions, descriptions of projection methodologies, and references to the underlying survey reports, see appendix A.

Performer Reporting Basis

SRS annually surveys Federal Government agencies, industry, and academia. Respondents in each sector indicate the amounts they spend on R&D in their own sector and the sources of these funds. National historical totals are based on data reported by performers because they are in the best position to (1) indicate how much they spent in the actual conduct of R&D in a given year, (2) classify their R&D by character of work, and (3) identify the sector of the economy in which their financing originated. The consistent reliance on performer reporting reduces the possibility of double-counting and conforms to international standards and guidance.

There are exceptions to the use of performer-reported data. The last complete survey of the nonprofit sector was conducted in 1973, although a survey of nonprofit R&D activity is planned for 1997. Since 1973, informal surveys of this sector have been undertaken periodically; nonetheless, the estimates of R&D performance by nonprofit organizations reported here are based generally on (1) Federal agency reporting of Federal funding to the nonprofit sector and (2) R&D performance trends in the other non-Federal sectors.

NSF conducts only occasional surveys of State government agencies; the last two surveys covered fiscal years (FYs) 1977 and 1987-88. Consequently, the national R&D time-series totals exclude estimates of State agencies' intramural R&D performance. State funds for R&D reported by other sectors of the economy, however, are included in the respective R&D performance totals.

One byproduct of the decision to use performer-reported data is that the federally funded R&D performance totals presented in *National Patterns* differ from the Federal R&D funding totals reported by the Federal agencies that provide the funds. One reason for these differences is that performers of R&D often expend Federal funds in a year other than the one in which the Federal Government provides authorization, obligations, or outlays. (For definitions of these terms, see appendix A.) During the past several years, the differences have widened between the Federal R&D funding reported by performers and that reported by funding agencies. These trends are documented in appendix A and tables B-1 and B-2.

Projections

Although respondents continually are given the opportunity to revise prior data, the R&D totals for 1994 reported here are considered to be actual expenditures. Data reported for 1995 and 1996 are preliminary, in the sense that 1995 data are based on preliminary reporting of information; and 1996 data are

projections made during the summer of 1996 based on information available at that time. The series presented in this *National Patterns* updates projections for 1993 and 1994 that were reported in *National Patterns of R&D Resources: 1994*, including—in particular—revisions to industrial basic research data.

To the greatest extent possible, this report incorporates data for 1996 R&D programs contained in the administration's 1997 budget proposal. Where these data are used, it is explicitly noted in the text. The budget, however, does not contain estimates on the detailed disaggregation reported in *National Patterns*; most importantly, it includes very little information on the economic sectors receiving the Federal funds. Consequently, Federal agencies' R&D performance for 1995 and 1996 are derived from an NSF survey of 32 Federal agencies coinciding with the third quarter of FY 1995; therefore, the amounts reported for 1996 reflect congressional appropriations, apportionments, and reprogramming decisions as of that time.

Industry R&D performance for 1996 is derived from patterns observed in previous years, and from 151 company responses to a mail survey of the Industrial Research Institute's (IRI's) membership during August and September 1995. IRI, which annually conducts this survey, is an association of more than 260 R&D-performing companies, representing such industries as aerospace, automotive, chemical, computer, and electronics.

R&D performance estimates for 1996 for the other sectors of the economy are derived from regression and time-series modeling techniques. Inputs to these models are (1) the performer-reported actual R&D performance data and (2) information on Federal R&D funding of non-Federal sectors, as reported by Federal agencies in the third quarter of FY 1995.

Expanded Detail in R&D Time Series

This *National Patterns* is the first to contain 1955–to–present estimates for those federally funded research and development centers (FFRDCs) administered by industrial firms and nonprofit organizations. Previous *National Patterns* contained separate detail on only those FFRDCs administered by universities and university consortia.

HIGHLIGHTS

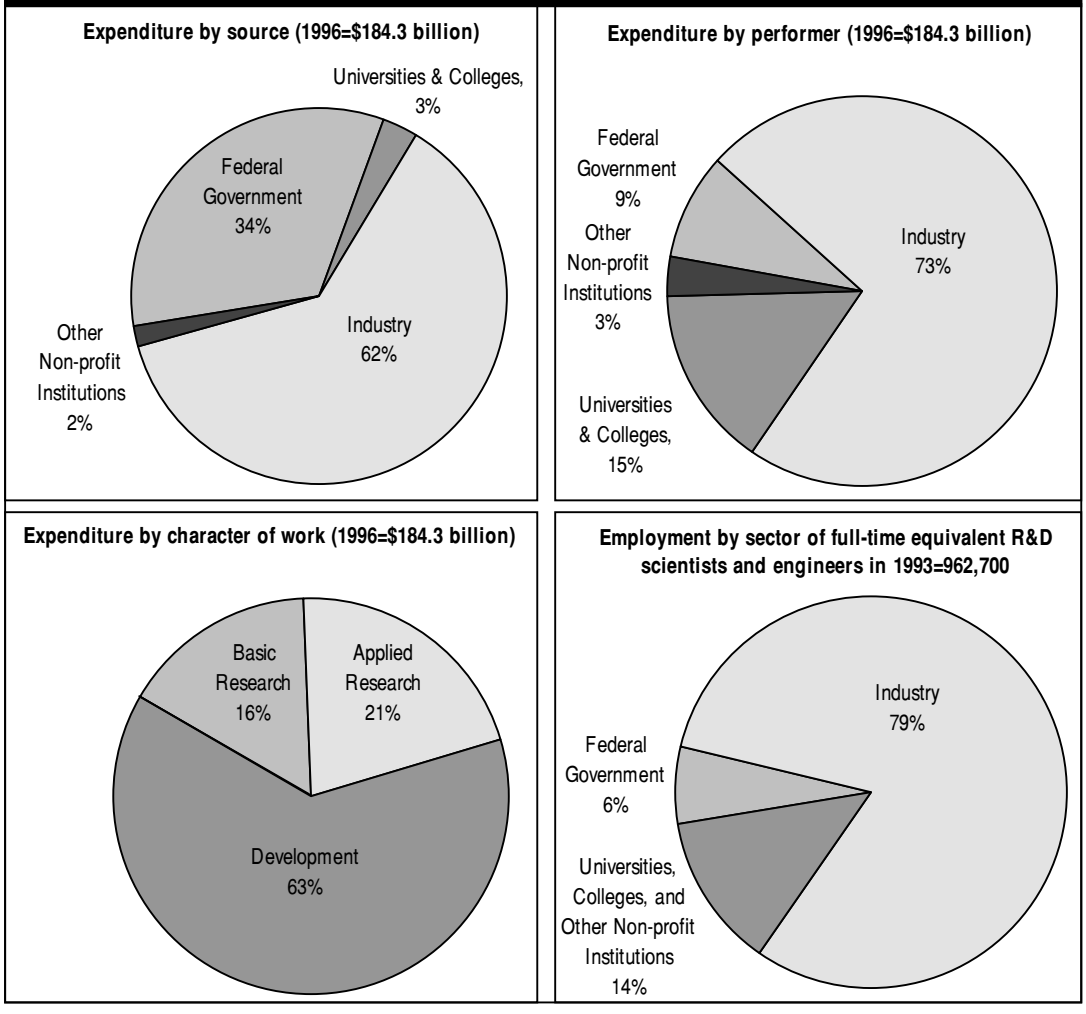
R&D EXPENDITURES

- According to projections, total R&D expenditures in the United States are expected to reach $184.3 billion in 1996—a 3.2 percent increase over the $178.6 billion spent in 1995. The preliminary 1995 figure represents a 6 percent increase in R&D spending over the 1994 level. In inflation-adjusted terms, total R&D expenditures rose by 4 and 1 percent in 1995 and 1996, respectively; the 1995 increase was the largest since 1985.

- R&D growth continues to be outpaced by the growth of the economy as measured by gross domestic product (GDP). Preliminary measurement of GDP growth indicates a 2.7 percent increase between 1995 and 1996 after adjusting for inflation—well over twice the growth in inflation-adjusted R&D.

- Industry will provide $113.5 billion for R&D in 1996, by preliminary tabulations, representing a 3.5 percent increase over 1995 spending in real (inflation-adjusted) terms. Preliminary Federal R&D funding in 1996 is expected to be $61.9 billion (chart 1), a 3.0 percent decline in real terms from the preliminary 1995 level. Most of the remaining R&D funds is expected to come from

Chart 1. The National Effort



NOTES: Details may not add to 100 percent because of rounding. R&D funds for federally funded R&D centers are included in their affiliated sectors.

SOURCE: National Science Foundation/SRS

universities and colleges and other nonprofit institutions, and the State and local governments supporting them. Their projected $9.0 billion in support in 1996 is virtually unchanged in real terms (only 0.3 percent higher) from the 1995 level. (These estimates are based on performer surveys and modeling techniques outlined in appendix A.)

- Growth in total U.S. R&D expenditures has been slow since the mid-1980s. From 1980 to 1985, R&D spending increased on average by 6.6 percent per year in real terms. From 1985 to 1996, it slowed to 1.4 percent, compared to a 2.6 annual real growth in GDP. Slackening in both Federal and non-Federal funding of R&D as a proportion of GDP has contributed to this slowing, though Federal funding has been declining at a faster rate.

- As a result of recent R&D trends, the proportion of GDP spent on R&D activities dropped to an estimated 2.48 percent in 1996, its lowest share since 1981.

- From 1980 to 1985, national expenditures on R&D activities were fueled largely by major increases in Federal funding for defense-related R&D programs. Defense R&D rose from 50 percent of the Federal R&D budget authority in 1980 to 68 percent in 1985. The defense share peaked at 69 percent in 1986 before declining fairly steadily to its preliminary 54.7 percent share of the 1996 Federal R&D budget authority (as proposed in the administration's 1997 budget).

- The Federal share of R&D funds first fell below 50 percent in 1978; between 1980 and 1988, the Federal Government consistently provided 45 to 47 percent of all funds spent on R&D in the United States. Its share has dropped substantially since then. Its preliminary share of 33.6 percent for 1996 is the lowest recorded since the present data series began in 1953.

- Non-Federal support for R&D fell from a 7.2 percent average annual real rate of increase over 1980-85 to a preliminary 3.3 percent growth rate for the 1985-96 period.

U.S.-International Comparisons

- The United States spends more money on R&D activities than does any other country. In fact, in 1994 it spent more than Japan, Germany, France, and the United Kingdom combined.

- In 1994—the latest year for which foreign data are available—the United States spent 2.49 percent of its GDP on R&D. In comparison, Japan spent 2.69 percent of its GDP; France, 2.38 percent; Germany, 2.33 percent; the United Kingdom, 2.19 percent; Canada, 1.57 percent; and Italy, 1.19 percent.

- The nondefense R&D/GDP ratio for the United States in 1994 was 2.00 percent; this was considerably lower than the ratios for Germany (2.26 percent) and Japan (2.66 percent). France and the United Kingdom, which have substantial defense R&D efforts, each reported nondefense R&D/GDP ratios closer to that of the United States—roughly 2.09 for France (in 1993—the figure for 1994 being unavailable) and 1.88 percent for the United Kingdom. The ratio for Canada was 1.53 percent, and Italy's was 1.14 percent.

R&D Performance by Sector

- Industry is expected to account for 73 percent of the Nation's 1996 R&D performance total. The projected $134.2 billion in R&D performance by industry represents a 2 percent real increase over the preliminary 1995 total. Most (83 percent and growing) of industry's expected R&D performance total, including industry-administered FFRDCs, will be company funded; Federal funding is likely to account for the rest (17 percent). The Federal share of industry's performance total has fallen considerably; it had been 33 percent of the industry total in 1987.

- The Federal Government will perform an estimated $16.2 billion of R&D in 1996 (in current dollars). This figure is slightly lower than the preliminary level for 1995, $16.4 billion, which reflects a real decline of 3.3 percent. Federal agencies account for 9 percent of the projected national R&D performance effort; this reflects a continuation in

the gradual decline of Federal funding as a percentage of total R&D that began in the mid-1970s. These statistics are exclusive of the R&D performance undertaken by FFRDCs, which are included in the totals of the administering sectors.

- Universities and colleges—excluding academically administered FFRDCs—account for 12 percent ($22.4 billion) of the projected 1996 national R&D performance effort. According to these preliminary findings, there has been virtually no change (less than 0.1 percent) between 1995 and 1996 in the amount of real R&D performance carried out at universities and colleges.

R&D Performance by State

- Data are available on the State distribution of 1993 R&D performance by industry, academia, and Federal agencies, and the federally funded R&D activities of nonprofit institutions. The distribution of R&D performance by State, not unlike the distribution of gross state product (GSP) by State, is highly concentrated.

- Six States (California, New York, Michigan, Massachusetts, New Jersey, and Pennsylvania, in decreasing order of R&D performance) accounted for roughly one-half of the U.S. total R&D in 1993; 10 States (adding Maryland, Texas, Illinois, and Ohio) accounted for approximately two-thirds. In each of these 10 States, at least $6 billion (in constant 1993 dollars) was spent on R&D.

- The highest 24 States in R&D, plus the District of Columbia (which would rank 20th in R&D performance if it were ranked as a State), collectively accounted for approximately 91 percent of the R&D conducted nationwide in 1993.

- As a percentage of GSP, R&D performance in New Mexico was largest—8.1 percent. California, which led the Nation in terms of total R&D performance ($33.7 billion in constant 1993 dollars), had an R&D/GSP ratio of 4.3 percent—seventh highest among the States.

Character of R&D Work

- Preliminary findings indicate that, in 1996, the United States will spend $29.8 billion on the performance of basic research (16 percent of total R&D expenditures), $38.8 billion on applied research (21 percent), and $115.8 billion on development (63 percent).

- Compared to 1995, R&D performance in 1996 reflects a projected 0.9 percent decrease, in real terms, for basic research; a 1.0 percent real increase for applied research; and a 1.5 percent real increase for development.

- The Federal Government provides the majority of funds for basic research. Its share of basic research support has dropped over time as a percentage of all support—from 70 percent in 1980 to a preliminary 58 percent in 1996.

R&D Scientists and Engineers

- The estimated number of scientists and engineers (S&Es) employed in 1993 on R&D activities in the United States was approximately 962,700. This figure reflects virtually no change (a 0.2 percent increase) from the 1991 level of 960,400. It reflects a 20 percent increase over the 1985 figure of 801,900, the first year for which revised national tabulations are derived.

- In 1993, industry employed 79.4 percent of these R&D personnel. The industrial classification with the largest share of these employees was the nonmanufacturing sector, which accounted for 25.3 percent of industry R&D employment. This finding illustrates a dramatic change from only 6 years earlier, when the transportation equipment industry

had nearly twice as many R&D personnel as the nonmanufacturing sector (187,800 employees versus 99,200, respectively).

- There were 463,000 employed doctoral scientists and engineers in the United States in 1993; 41 percent of these reported R&D as their primary work activity. Teaching as a primary activity accounted for 22 percent; management/sales/ administration, 18 percent; computer applications, 4 percent; and other professional services, 15 percent.

TRENDS IN NATIONAL R&D SUPPORT

U.S. expenditures on research and development (R&D) are expected to reach $184.3 billion in 1996 (chart 2). This figure represents a 3 percent increase over preliminary 1995 expenditures ($178.6 billion in current dollars) or a 1 percent change after adjusting for expected inflation.[1] The 1995 level of R&D expenditures represents a 6 percent increase, in current dollars, over the 1994 level ($168.1 billion). In inflation-adjusted terms, total R&D expenditures rose by 4 percent in 1995, the largest real increase since 1985. However, growth in R&D continues to be outpaced by growth of the economy, as measured by gross domestic product. GDP growth between 1995 and 1996 is expected to be approximately 5.0 percent in current dollars, or 2.7 percent after adjusting for inflation.[2]

In 1996, the Federal Government will provide 33.6 percent ($61.9 billion in current dollars) of total projected funds for R&D; industry will supply 61.6 percent ($113.5 billion in current dollars); and the remaining sectors of the economy—i.e., State governments, universities and colleges, and other nonprofit institutions—will contribute 4.9 percent ($9.0 billion).

This funding of R&D continues the trend of slow growth in real R&D support which began in 1986. Not since the early 1970s has there been a period of such protracted low growth in national R&D support. Starting in 1969 and for nearly a decade thereafter, R&D growth failed to keep up with either inflation or general increases in economic output. In fact, between 1968 and 1975, real R&D expenditures declined 7 percent; this drop was due to a deemphasis by both business and Government on funding for research programs. Federal funding in particular fell considerably during this period (down 21 percent in real terms). Both Federal defense- and nondefense-related R&D programs declined (chart 2).

Following the economic recovery from the 1974 oil embargo and the 1975 recession, a significant funding reversal occurred. U.S. R&D expenditures increased in real terms by approximately 67 percent from 1975 to 1985, compared with a 33 percent rise in real GDP over the same period.

During the first half of this period (1975-80), there was considerable growth in Federal R&D funding for nondefense activities. Although defense-related R&D expenditures rose annually, much of the Federal R&D gain was attributable to energy-related R&D (particularly nuclear energy development) and to greater support for health-related R&D. Non-Federal R&D increases were concentrated in industry and resulted largely from greater emphasis on energy conservation and improved use of fossil fuels. Consequently, energy concerns fostered increases in R&D funding by both Federal and non-Federal sources. Support for energy R&D rose 140 percent in real terms between 1974 and 1979 and accounted for one-half of the national increase in real R&D spending.

Overall, the U.S. constant-dollar investment in total R&D grew at an average annual rate of 3.9 percent during 1975-80. Although the rate of increase remained rather steady through 1982 (approximately 4 percent annually), the focus of the national R&D effort began to shift heavily toward defense-related activities in the early 1980s.[3] Largely as a result of increases in defense R&D, growth in real R&D expenditures accelerated to an average annual rate of 8.1 percent over 1982-85: Not since the spending initiative toward space exploration in the early 1960s had R&D in the United States grown so rapidly during any 3-year period. On average, from 1980 to 1985, R&D spending increased 6.6 percent per year in real terms.

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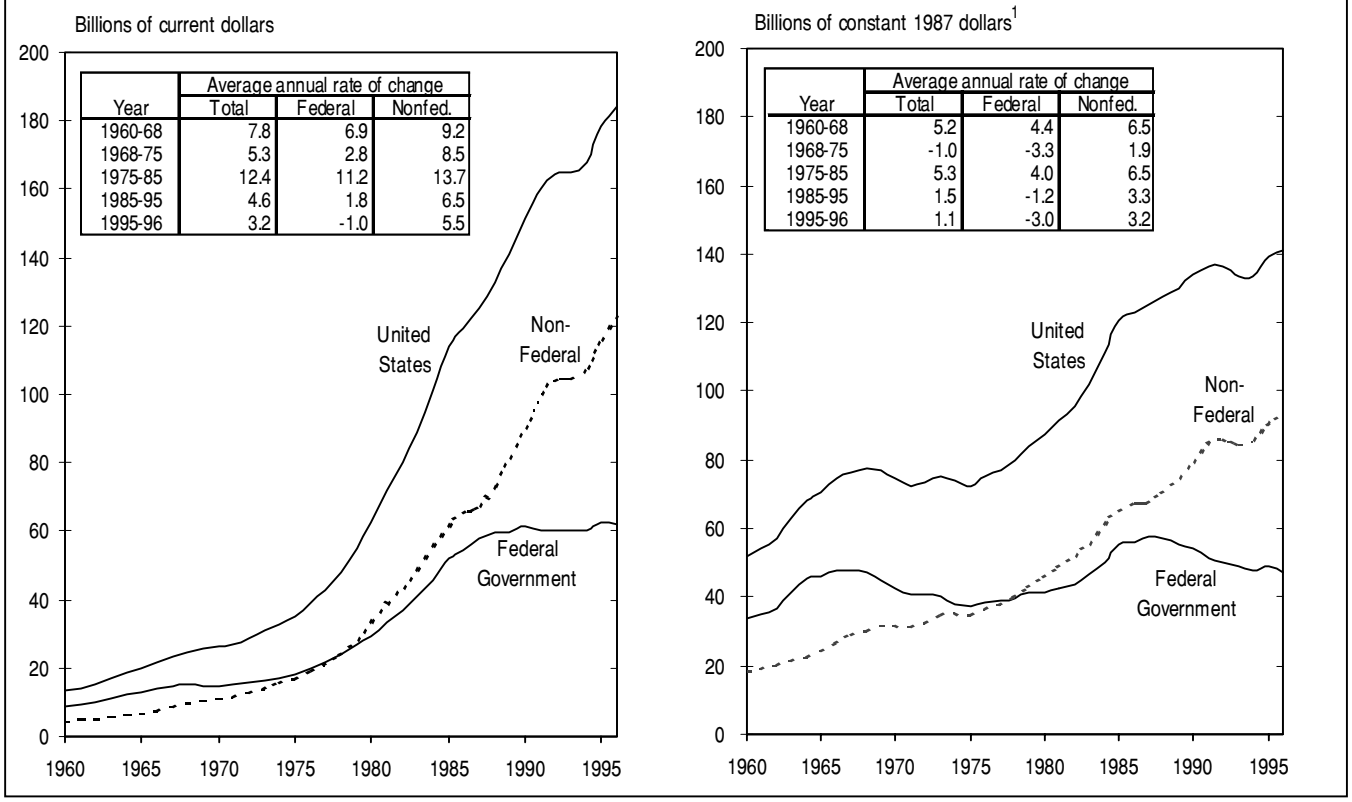
[1] For a discussion of how dollar amounts are adjusted for inflation in this report, see appendix A, section on "Controlling for Inflation and Foreign Currency."

[2] Expressions like "R&D growth *in 1996*" and "R&D growth *between 1995 and 1996"* are equivalent, because both measure the change in R&D from year-end 1995 to year-end 1996. When intervals are given, the comparison is made between year-end figures for the years mentioned, e.g., "R&D growth in 1990-1996" refers to the change from year-end 1990 to year-end 1996.

[3] Industry R&D expenditures on energy and pollution abatement also slowed at this time. In fact, in 1981 and 1982, such expenditures increased at only one-third the rate reported for the previous 4 years.

Chart 2. National R&D funding, by source: 1960-96



[1] Based on GDP implicit price deflator.

NOTE: Data are preliminary for 1995 and 1996.

SOURCE: National Science Foundation/SRS; table C-3

This pattern of a generally increasing rate of real R&D growth, however, changed abruptly in the mid-1980s. From 1985 to 1996, R&D spending slowed to a 1.4 percent annual real rate of increase, compared to a 2.6 annual real growth in GDP. Some slackening of both Federal and non-Federal funding of R&D as a proportion of GDP has contributed to this slowing. However, it is primarily the decline in real Federal R&D funding, as reported by R&D performers, that has contributed to the recent slowness of R&D growth.[4]

Trends in Federal Support

As a share of the national R&D total, Federal Government funding has continued to decline in recent years. Previously the primary provider of the Nation's R&D funds, the Federal Government's share of R&D funding first fell below 50 percent in 1978. From 1980 to 1988, the Federal Government accounted for between 45 and 47 percent of total R&D funding. The preliminary Federal R&D funding in 1996, $61.9 billion (chart 1), represents a 3 percent decline from the preliminary 1995 level in real terms. Consequently, the Federal Government's estimated share of R&D support for 1996, 33.6 percent, is the lowest recorded since the present data series began in 1953.[5]

Even with its declining share of the national total, Federal R&D funding grew from $41.4 billion in 1980 (in constant 1987 dollars) to a preliminary level of

[4] In recent years, increasing differences have been detected in data on federally financed R&D as reported by Federal funding agencies, on the one hand, and by performers of the work (Federal labs, industry, universities, and other nonprofit organizations), on the other hand. This divergence in R&D totals is discussed in appendix A (and tables B-1 and B-2).

[5] The sample design for estimating industry R&D expenditures was revised for 1991 and later years. The effect of the change in industry's sample design was to reduce the Federal share of the national R&D total to 38 percent in 1991, down from the 41 percent share previously published for that year. See appendix A (and table B-4) for more information on these survey changes and their impact on R&D estimates.

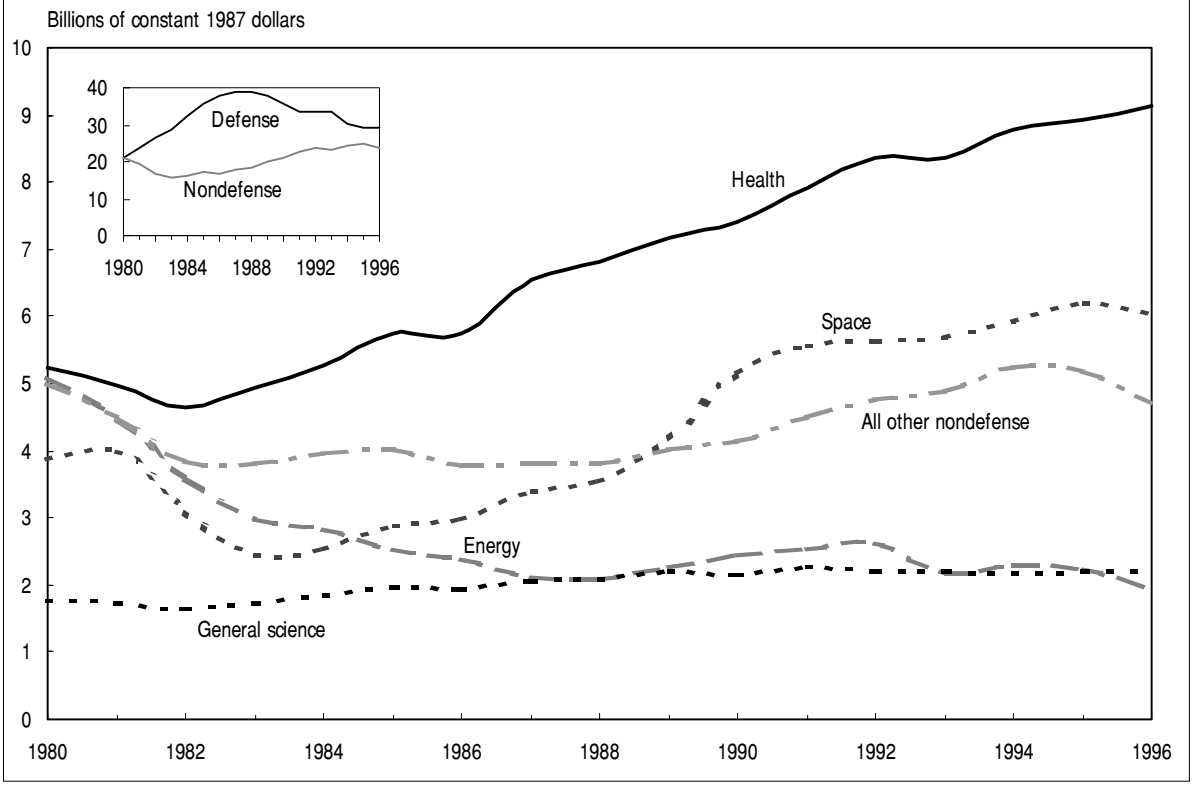
$47.4 billion in 1996 (in constant 1987 dollars); i.e., it grew by roughly 0.9 percent per year in real terms during this period. The rate of increase was strongest in the early 1980s and accounted for most of the gain for the entire decade. From 1980 to 1985, Federal R&D funding grew, on average, by 5.9 percent in real terms annually. Support then slowed considerably in 1986, reflecting the budgetary constraints imposed on all Government programs, including those mandated by the Balanced Budget and Emergency Deficit Control Act of 1985 (also known as the Gramm-Rudman-Hollings Act) and subsequent legislation (notably the Budget Enforcement Act of 1990, which legislated that new spending increases be offset with specific spending cuts). Since then, Federal R&D data reflect the Government's growing emphasis on deficit reduction and a shift in the balance between defense and domestic programs. Consequently, real Federal R&D support has declined on average by 1.4 percent per year over the 1985-96 period, by preliminary calculations.

Practically all the gain in Federal R&D funding during the early 1980s was due to large increases in defense spending, as evidenced by the figures on the U.S. budget authority (chart 3). For example, defense activities of the Department of Defense (DOD) and the Department of Energy (DOE) accounted for roughly one-half of total Federal R&D budget authorizations in 1980.[6] By 1986, such defense-related spending peaked at 69 percent of the Federal R&D budget authority.

After 1986, Federal R&D spending priorities shifted—partially because of additional budgetary pressures, partially because of modifications in U.S. security measures in the international arena. Thus, the defense buildup in the early and mid-1980s was followed by a period of moderate reductions in the late 1980s; a leveling of R&D spending in the early 1990s;

[6] These percentage share calculations of defense-related R&D expenditures are based on Federal budget authorization totals, not on data reported by the performers of R&D.

Chart 3. Federal R&D budget authority, by function: 1980-96



NOTE: Data are preliminary for 1995 and 1996.

SOURCE: National Science Foundation/SRS; table C-23

and a return to planned, moderate reductions in the mid-1990s. Since 1986, the Federal budget authority for civilian-related R&D has grown faster than defense-related R&D. In particular, the budget allocation for health- and space-related R&D increased substantially between 1986 and 1996, with average real annual growth rates of 4.7 and 7.2 percent, respectively, using preliminary figures for 1996. The budget allocation for defense programs declined by an average real annual rate of 2.7 percent during the same period. As a result, in 1996, defense-related R&D accounts for an estimated 54.7 percent of the year's total Federal R&D budget authority, in contrast to 69.3 percent for 1986.

Based on preliminary figures, R&D accounts for more than 14 percent of the Federal defense-related budget authority for 1996, and 3 percent of the Federal nondefense authority (table 1). In nondefense areas, R&D accounts for 69 percent of general science funds, nearly all of which (94 percent) is devoted to basic research (table 2). R&D accounts for 63 percent of funds for space research and technology, most of which (63 percent) is devoted to development. In total Federal health funding, R&D represents 11 percent, most of which ($6.4 billion out of $11.9 billion) is devoted to basic research (table 2), and nearly all of which (95 percent) is directed toward programs of the National Institutes of Health (NIH).

Federally funded R&D on energy actually exceeds the total Federal budget authority for all energy-related activities. This is because the Department of Energy, through the sale of assets in 1996, had substantially more funds to spend in that year than it received from the Federal budget. Consequently, federally funded energy R&D as a percentage of the total budget for energy-based activities in 1996 is 125.9 percent (table 1).

For the Nation as a whole, defense-related R&D climbed from 24.1 percent of the total R&D effort in 1980 to 31.7 percent in 1987. In 1996, defense-related R&D fell to 17.9 percent of total R&D expenditures, according to preliminary findings (chart 4). These shares by national objective represent a distribution of performer-reported R&D data. They are distinct from the budget authority shares reported above which are

Table 1. R&D as a percentage of Federal budget authority, by function: FY 1996

Budget function	R&D total (preliminary 1996)	Federal Total	R&D percentage share
	millions of current dollars		
Total	69,069	1,571,597	4.4
On budget	69,069	1,263,491	5.5
National defense	37,791	263,308	14.4
Nondefense (on-budget)	31,279	1,000,183	3.1
Health	11,902	110,867	10.7
Space research and technology	7,871	12,543	62.8
Energy	2,504[1]	1,989[1]	125.9[1]
General science	2,862	4,166	68.7
Natural resources and environment	1,877	20,669	9.1
Transportation	1,752	37,118	4.7
Agriculture	1,178	6,935	17.0
All other	1,334	805,896	0.2

[1] R&D is greater than total budget authority because of offsetting receipts from sales of the Strategic Petroleum Reserve, which reduced total budget authority. Includes budget authority from mandatory spending.

NOTES: Because of rounding, components may not add to the totals shown. Data are derived from the administration's 1997 budget proposal. On-budget totals are for all Federal Government transactions except those of the social security trust funds (Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds) and the Postal Service.

SOURCES: National Science Foundation/SRS, and Office of Management and Budget

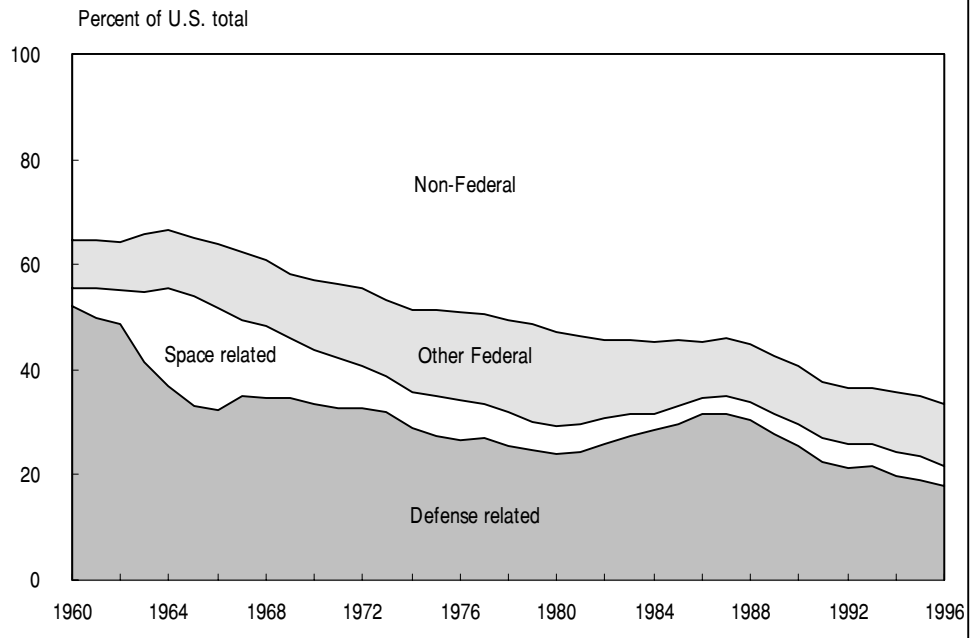
Table 2. Budget authority for R&D by function and character of work: Preliminary FY 1996

Budget function	Basic Research	Applied Research	Development	R&D Total
	millions of current dollars			
Total	14,431	13,763	40,875	69,069
National defense	1,204	3,746	32,840	37,791
Nondefense (total)	13,228	10,016	8,035	31,279
Health	6,442	4,064	1,396	11,902
Space research and technology	1,563	1,322	4,986	7,871
Energy	1,222	522	760	2,504
General science	2,685	177	0	2,862
Natural resources and environment	179	1,419	279	1,877
Transportation	366	1,123	264	1,752
Agriculture	556	557	65	1,178
All other	216	833	285	1,334

NOTES: Because of rounding, components may not add to the totals shown.

SOURCES: National Science Foundation/SRS, *Federal R&D Funding by Budget Function: Fiscal Years 1995-97* NSF 97-301, and unpublished tabulations

Chart 4. R&D spending as a percent of total, by national objective and source: 1960-96



NOTES: Data are preliminary for 1995 and 1996. Details may not sum to totals because of rounding.

SOURCE: National Science Foundation/SRS; table C-14

based on the various functional categories that comprise the Federal budget. (See appendix A.) Between 1982 and 1996, space-related R&D funding has annually accounted for between 3 and 5 percent of the national R&D total.

With regard to "civilian-related" R&D (nondefense-nonspace programs), Federal funding accounts for 11.7 percent of total R&D (Federal and non-Federal) in 1996, by preliminary calculations (table C-14). This percentage is not much higher than it was in 1993, 10.6 percent, which was the lowest it had been since 1962. Such federally supported, civilian-related R&D as a percentage of all U.S. R&D reached a peak of 18.6 percent in 1979, but has remained relatively constant—between 10 and 12 percent—since 1986.

Preliminary estimates of Federal R&D obligations for 1996 indicate that seven Federal agencies have R&D obligations of over $1 billion: DOD, DOE, the Department of Health and Human Services (HHS), the National Aeronautics and Space Administration (NASA), NSF, and the Departments of Agriculture and Commerce. DOD has the largest share (49 percent) of Federal R&D obligations ($33.7 billion), followed by HHS (17.2 percent), NASA (11.8 percent), DOE (9.9 percent), NSF (3.3 percent), Department of Agriculture (2.0 percent), and Department of Commerce (1.9 percent) (table 3).

In contrast to total R&D obligations, only three agencies have intramural R&D expenditures that exceed $1.0 billion in 1996, including costs associated with planning and administering extramural R&D programs: DOD, HHS (which includes NIH), and NASA.[7] These three agencies together account for 77.9 percent of all Federal R&D obligations for 1996, and 75.0 percent of Federal intramural R&D.

Trends in Non-Federal Support

Concurrent with the 1980-85 gains in Federal R&D spending, R&D support from non-Federal sources also grew substantially—by 7.2 percent per year after inflation during this period. However, between 1985 and 1996, by preliminary calculations, growth of non-Federal real R&D funding slowed considerably, to an average annual rate of 3.3 percent.

Most non-Federal R&D support is provided by industry. Of the projected 1996 non-Federal total ($122.4 billion in current dollars), 92.7 percent ($113.5 billion) is company funded. This level of industry funding represents a real increase of 3.5 percent over its 1995 level. Industry's share of national R&D funding had first surpassed that of the Federal Government in 1980, and it has remained higher ever since. From 1980 to 1985, industrial support for R&D grew, in real terms, at an average annual rate of 7.3 percent. This growth was maintained through both the mild 1980 recession and the more severe 1982 recession (chart 5). Key factors behind increases in industrial R&D included a growing concern with international competition, especially in high-technology industries; the increasing technological sophistication of products, processes, and services; and general growth in defense-related industries such as electronics, aircraft, and missiles.

Between 1985 and 1994, growth in R&D funding by industry was much slower than previously, averaging only 2.8 percent per year in real terms. The growth in industrial R&D funding was only slightly greater than the growth of the economy (2.5 percent) over the same period in terms of real GDP. However, on the basis of preliminary figures for 1995 and 1996, industrial R&D support from 1994 to 1996 grew, in real terms, by 4.8 percent per year, compared with a 3.0 percent real annual growth in the economy over the same period.

While these figures indicate general trends, as an examination of the industrial sector in the aggregate, they reveal little about the underlying factors influencing R&D performance or support, because R&D budget decisions vary substantially across different industries. Thus, trends in industrial R&D may be as

[7] Estimates are for FY 1996 Federal intramural obligations as reflected in the administration's 1997 budget proposal (see appendix A) and cover costs associated with planning and administering intramural and extramural R&D programs by Federal personnel as well as actual intramural R&D performance. See NSF, *Federal Funds for Research and Development: Fiscal Years 1994, 1995, and 1996*, NSF 94-328 (Arlington, VA, 1996).

Table 3. Preliminary Federal R&D obligations, total and intramural by agency: FY 1996

Agency	Total R&D obligations (millions of current dollars)	Total R&D obligations as a percent share of Federal total	Intramural R&D (millions of current dollars)	Percent of Agency R&D obligations that are intramural[1]	Percent change in real intramural R&D from previous year[2]
Department of Defense	33,706.0	48.96	7,848.2	23.3	-11.8
Department of Health & Human Services[3]	11,828.2	17.18	2,345.4	19.8	1.1
National Aeronautics & Space Administration	8,105.7	11.77	2,026.4	25.0	-7.3
Department of Energy	6,842.3	9.94	706.7	10.3	11.4
National Science Foundation	2,303.1	3.35	22.6	1.0	7.1
Department of Agriculture	1,393.1	2.02	937.9	67.3	-1.2
Department of Commerce	1,325.8	1.93	741.8	56.0	9.7
Department of Transportation	710.1	1.03	244.1	34.4	18.5
Department of the Interior	683.2	0.99	595.9	87.2	-1.6
Environmental Protection Agency	676.4	0.98	150.7	22.3	13.6
Department of Veterans Affairs	258.0	0.37	256.0	99.2	-2.6
Agency for International Development	222.0	0.32	25.4	11.4	-39.8
Department of Education	188.3	0.27	8.9	4.7	3.9
Smithsonian Institution	129.2	0.19	129.2	100.0	1.2
Tennessee Valley Authority	103.4	0.15	103.4	100.0	8.9
Nuclear Regulatory Commission	81.8	0.12	12.8	15.6	-2.7
Department of Labor	67.2	0.10	10.1	15.0	0.1
Department of Justice	53.5	0.08	14.3	26.7	-16.0
Department of the Treasury	52.8	0.08	43.9	83.1	2.0
Department of Housing & Urban Development	42.5	0.06	21.5	50.6	-13.9
Social Security Administration[3]	37.2	0.05	16.0	43.0	NA
US International Trade Commission	10.8	0.02	10.8	100.0	3.8
Library of Congress	9.7	0.01	9.7	100.0	-1.9
Department of State	5.4	0.01	0.4	7.4	-1.9
Other Agencies[4]	7.0	0.01	5.3	75.7	-3.7
Entire Federal Government[5]	68,842.4	100.00	16,287.3	23.7	-5.8

[1] Intramural activities include actual intramural R&D performance and the costs associated with the planning and administration of both intramural and extramural programs by Federal personnel. For the definition of intramural performers, see Definitions for Classification and Measurement, in Appendix A.

[2] Based on fiscal year GDP implicit price deflators for 1995 and 1996 (Table C-1).

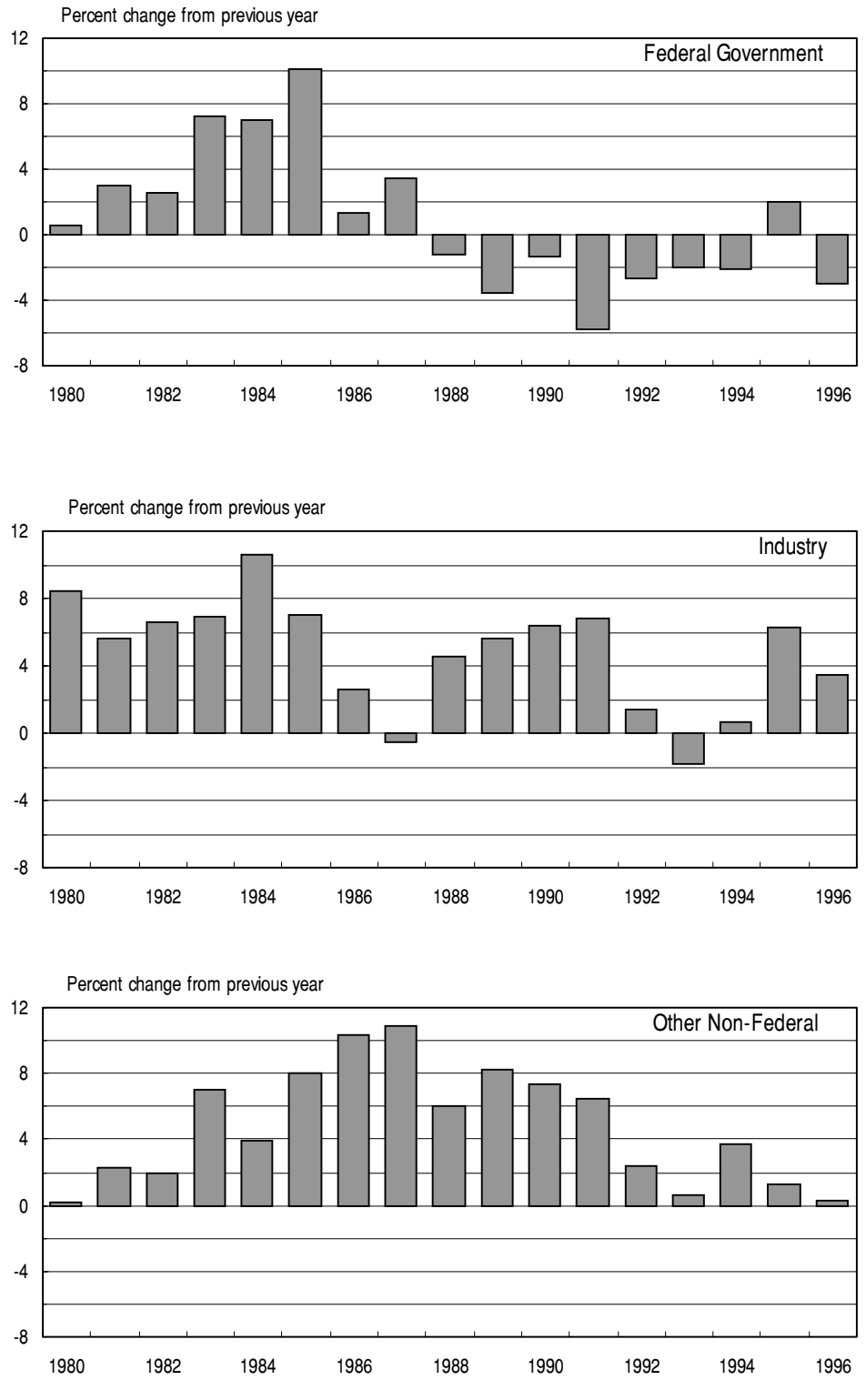
[3] As of March 31, 1995, the Social Security Administration became an independent agency, and no longer part of the Department of Health and Human Services.

[4] Includes: Advisory Commission on Intergovernmental Relations, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, National Archives and Records Administration, US Arms Control and Disarmament Agency, and US Information Agency.

[5] Numbers do not total exactly, due to rounding.

SOURCE: National Science Foundation/SRS, Survey of Federal Funds for Research and Development: Fiscal Years 1994, 1995, and 1996

Chart 5. Annual changes in national R&D spending, by source of funds: 1980-96 (based on constant 1987 dollars)



NOTE: Data are preliminary for 1995 and 1996.

SOURCE: National Science Foundation/SRS; table C-3

much dependent on specific factors affecting specific industries within the economy as they are dependent on global factors that affect all industries as a whole.

Companies with the largest annual growth in real R&D performance from non-Federal sources between 1984 and 1994 have been in the following industrial sectors: nonmanufacturing[8] (18.1 percent); chemicals and allied products, rubber products, and other manufacturing industries[9] (each slightly more than 4.4 percent); and paper and allied products (slightly under 4.4 percent). Those industries experiencing the greatest annual declines (negative growth) in R&D over the same period were: stone, clay, and glass products (-5.5 percent); machinery (-4.7 percent); petroleum refining and extraction (-4.6 percent); and primary metals (-3.4 percent) (table 4).

National R&D funding from other non-Federal sectors—namely academic and other nonprofit institutions, including the support they receive from State and local governments—has been generally more consistent over time. It grew at an average annual real rate of 4.6 percent between 1980 and 1985, and, by preliminary calculations, 5.2 percent between 1985 and 1996. The projected $9.0 billion in funding in 1996 is virtually unchanged in real terms (only 0.3 percent higher) from its 1995 level. Most of these R&D dollars are used for research within the academic sector.

[8] See appendix A, section on "Use of 'Nonmanufacturing' as a Single Industrial Category." Also note that, as a result of recent improvements (since 1992) in the NSF sampling of firms located in the service sector, it is not clear to what extent the nonmanufacturing sector has rapidly expanded its share of the Nation's R&D, or how much of the apparent increase is due solely to improved measurement techniques.

[9] These include companies in Standard Industrial Classification Codes 27, 31, and 39, which are, respectively: printing, publishing, and allied industries; leather and leather products; and miscellaneous manufacturing industries (e.g., jewelry, musical instruments, toys, pens, burial caskets, and scenery for theaters).

Table 4. Change in non-federal funds for industrial R&D, by industry: 1984-94

Industry	SIC code(s)	R&D in millions of current dollars		Average annual growth in real R&D (percent)
		1984	1994	
Nonmanufacturing industries[1]	--	3,252	23,756	18.09
Chemicals and allied products	28	7,736	16,559	4.44
Rubber products	30	671	1,432	4.41
Other manufacturing industries	27,31,39	373	796	4.41
Paper and allied products	26	594	1,263	4.37
Professional and scientific instruments	38	4,211	8,058	3.28
Textiles and apparel	22,23	182	316	2.28
Transportation equipment	37	10,406	17,695	2.07
Electrical equipment	36	9,037	13,537	0.78
Lumber, wood products, and furniture	24,25	143	201	0.14
Food, kindred, and tobacco products	20,21	1,081	1,476	-0.15
Fabricated metal products	34	773	868	-2.08
Primary metals	33	683	672	-3.37
Petroleum refining and extraction	13,29	2,245	1,939	-4.62
Machinery	35	9,312	8,011	-4.66
Stone, clay, and glass products	32	705	553	-5.53

[1] The definition of this group in terms of the SIC codes it includes changes between 1990 and 1991, limiting the usefulness of comparing 1984 and 1994 figures. (See table C-30.)

Sources: National Science Foundation/SRS; derived from tables C-1 and C-30

MEASURES AND COMPARISONS OF NATIONAL RESOURCES FOR R&D

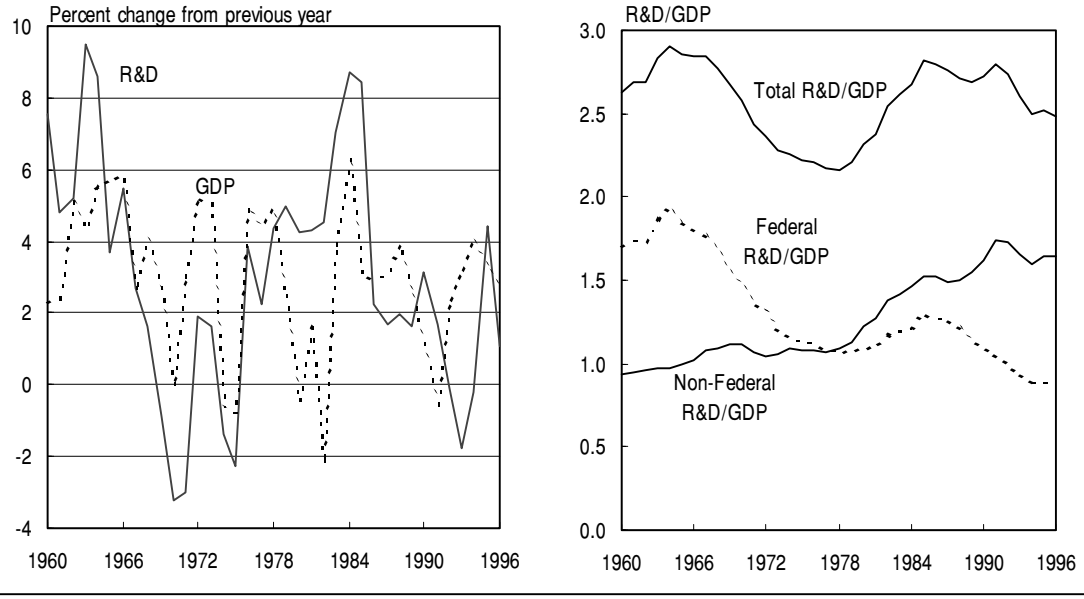
This section examines two indicators of R&D spending: (1) the ratio of total R&D expenditures to GDP and (2) the ratio of Federal funds expended for R&D to total Federal funds. Also presented is a comparison of U.S. R&D resources with those of other countries. These measures and comparisons show that the U.S. commitment to R&D seems to have plateaued during the past decade. Relative to the increases of its major international competitors, the U.S. R&D effort has eroded slightly, although many of these countries are also now experiencing a reduction in their R&D expenditures.

U.S. R&D/GDP RATIO

Growth in R&D expenditure should be examined in the context of the overall growth of the economy during the same period, given the significance of such factors as population growth, capital accumulation, and technological advancement. The ratio of R&D expenditures to GDP may be used as a measure of the Nation's commitment to R&D. In 1996, total U.S. support for R&D is expected to reach $184.3 billion. This sum represents 2.48 percent of estimated GDP— $7.428 trillion—slightly lower than the preliminary 1995 percentage of 2.52 (table C-15).

A review of U.S. R&D expenditure as a percentage of GDP over time shows an initial low of 1.38 percent in 1953 at the start of the time series, rising to a peak of 2.91 percent in 1964, followed by a gradual decline to 2.16 percent in 1978. The current expected ratio of 2.48 for 1996 is the lowest it has been since 1981, and reflects a downward trend since 1991. The initial drop in the R&D/GDP ratio from its 1964 peak largely reflected Federal cutbacks in defense and space R&D programs, although gains in energy R&D activities between 1975 and 1979 resulted in a relative stabilization of the ratio at around 2.2 percent. Over the entire 1965-78 period, the annual percentage increase in real R&D was less than the annual percentage increase in real GDP (chart 6).

Chart 6. Annual changes in GDP and R&D, and the R&D/GDP ratio: 1960-96 (based on constant 1987 dollars)



NOTE: Data are preliminary for 1995 and 1996.

SOURCE: National Science Foundation/SRS; tables C-1 and C-15

From 1978 to 1985, the R&D/GDP ratio increased steadily from 2.16 to 2.82 percent. This increase was as much due to a slowdown in GDP growth as to increased spending on R&D activities. For example, the 1980 and 1982 recessions resulted in a slight decline in real GDP with no corresponding reduction in R&D spending. In contrast, during previous recessions, changes in funding for R&D tended to match or exceed the adverse movements of the broader economy.

Since 1985, the R&D/GDP ratio has exhibited a downward trend, due to declining growth in Federal R&D expenditures and slow-to-declining growth in non-Federal R&D expenditures.[10] In the 11 years from 1985 to 1996, real GDP grew by 2.6 percent per year, while R&D grew by only 1.4 percent.

[10] See appendixes A and B for explanations and summary statistics detailing the effects on the U.S. R&D/GDP ratios from recent changes in the NSF survey of industry R&D performance.

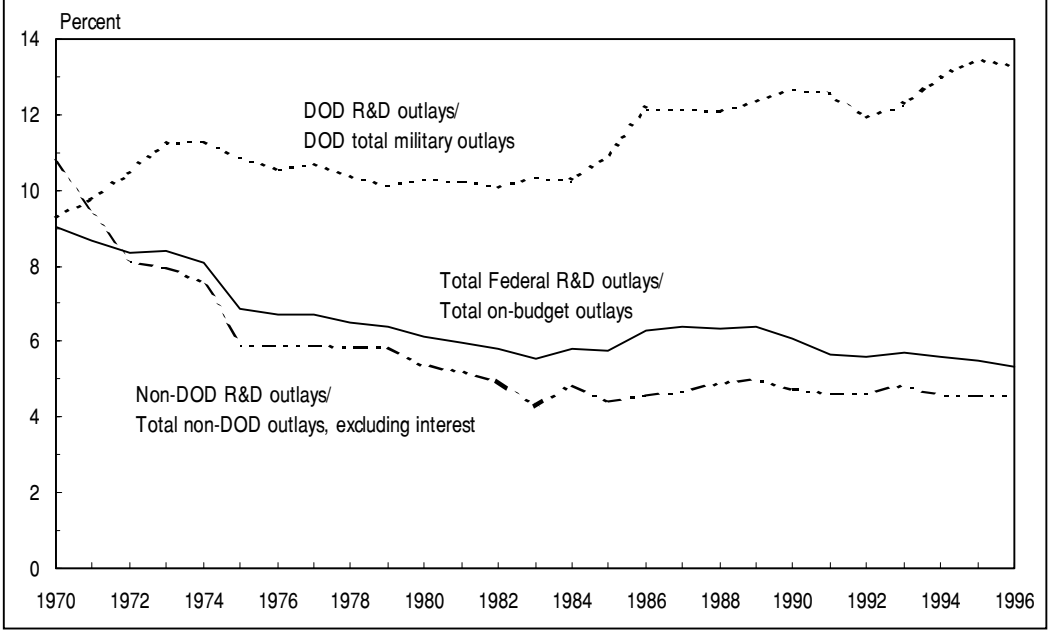
U.S. Federal R&D Funds/ Total Budget Ratio

One way to gauge the Government's priority for R&D is to compare Federal outlays for R&D with Federal outlays for all purposes.[11] Total Federal outlays (for on-budget programs only) for 1996 are estimated at $1.27 trillion.[12] R&D is expected to account for 5.3 percent ($67.7 billion) of those total outlays (chart 7 and appendix table C-24).

[11] This idea is applicable in most years. However, in some years, Federal outlays for purposes other than R&D may reflect extenuating circumstances such as a major war rather than "the Government's priority for R&D."

[12] Almost all off-budget receipts and disbursements are for social security programs (the Federal Old-Age and Survivors Insurance and the Federal Disability Insurance trust funds) which are excluded from the budget totals by the Balanced Budget and Emergency Deficit Control Act of 1985. Preliminary off-budget outlays for FY 1996, as provided in the President's 1997 budget proposal, are $302 billion (in current dollars). See Office of Management and Budget, *The Budget of the United States Government, Fiscal Year 1997* (Washington, DC: U.S. Government Printing Office, 1996).

Chart 7. Ratio of Federal R&D outlays to total budget outlays: 1970-96



NOTES: Excludes off-budget outlays, which are mostly for social security programs. Data are preliminary for 1995 and 1996. DOD R&D outlays are not strictly comparable to "defense R&D", as they do not include Department of Energy (DOE) atomic weapons R&D.

SOURCES: National Science Foundation/SRS, Department of Commerce, and Office of Management and Budget; table C-24.

From 1970 to 1983, R&D outlays as a percentage of total outlays declined steadily—especially during the early 1970s—dropping from 9.0 to 5.5 percent. This trend was dominated by a sharp fall in nondefense R&D outlays as a proportion of all nondefense outlays (excluding interest on the national debt), which declined from 10.7 percent in 1970 to 4.3 percent in 1983. The declining share of nondefense R&D was not confined to one or two agencies but was a result of both slow growth in most non-DOD agencies' R&D outlays and a relatively rapid expansion of the non-R&D component of the Federal budget for civilian agencies. In contrast, throughout the same period, R&D conducted by the Defense Department as a proportion of total DOD outlays went from a low of 9.3 percent in 1970, to a peak of 11.3 percent in 1974, to 10.3 percent by 1983.

After 1983, the percentage of all Federal outlays devoted to R&D first moved up and then back down. The ratio peaked at 6.4 percent in each year of the 1987-89 period, but has dropped steadily since then to a preliminary level of 5.3 percent in 1996. Most of the increases in Federal R&D/total outlays in 1984-86 were due to relatively large increases in DOD R&D outlays. Before 1990, this increase in DOD R&D was not offset by the relative decline in non-DOD R&D—as had been the case in the 1970s—or by the growing share of the Federal budget for interest payments.[13] In the 1990s, the declining R&D outlay ratio can be attributed to a relative decrease in non-DOD R&D as a proportion of non-DOD, non-interest, outlays. Concurrently, however, R&D has taken on relatively increasing importance in a shrinking DOD budget.

International Comparisons

Given the size of its economy, the United States spends more money on R&D activities than does any other country. In fact, it spends more than Japan, Germany, France, and the United Kingdom combined (appendix table C-21). Yet from 1990 to 1994, total R&D expenditures stagnated or declined in the United States, Japan, Germany, France, the United Kingdom, and Italy. Indeed, for more than a decade, these countries have displayed similar aggregate R&D trends: substantial inflation-adjusted R&D growth in the early 1980s, followed by a general tapering off in the late 1980s, and then level or declining real R&D expenditures into the 1990s. For most of these countries, economic recessions and budgetary constraints had the effect of slowing both industrial and government sources of R&D support. In particular, both factors contributed to major reversal of R&D trends in Japan, where R&D spending declined recently after experiencing inflation-adjusted gains of about 8 percent annually during the previous decade. The same is true for the United Kingdom and Italy, where real growth in the 1980s gave way to declining R&D expenditures thereafter (chart 8).

Additionally, geopolitical changes have resulted in cutbacks in government support for defense-related R&D that, in turn, have reduced reported national R&D growth patterns in some countries—most notably, the United States and France. For Germany, the integration of the former East German science and technology system into that of West Germany's market economy resulted in an apparent jump in the nation's R&D effort in 1991. This growth, however, was subsequently scaled back in an effort to restructure and close unnecessary research institutions.[14]

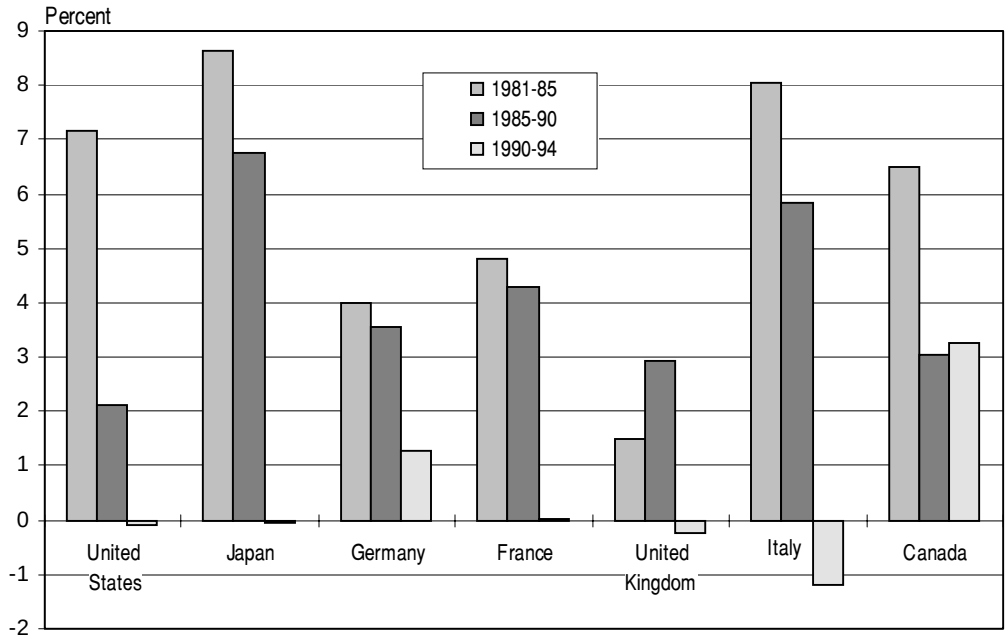
R&D/GDP Ratios

The R&D/GDP ratio discussed above can be used to determine the relative emphasis placed on R&D activities by the United States and other countries, which is not directly related to the size of their economies. Use of this ratio bypasses many of the problems in interpretation caused by inflation, exchange-rate fluctuations, different unit costs, and variations in the volume of research efforts. Caution must nonetheless be exercised in making even these international comparisons, because each country measures its R&D somewhat differently.

[13] As a percentage of total Federal on-budget outlays, interest payments on the national debt rose from 13.8 percent in 1983 to 19.4 percent in 1989. In 1996, the preliminary share of on-budget outlays for interest payments is 21.8 percent (see table C-24).

[14] For more detailed discussion of these changes, see National Science Board, *Science & Engineering Indicators—1996*, NSB 96-21 (Washington, DC: U.S. Government Printing Office, 1996).

Chart 8. Annual rates of change in real R&D spending, by selected countries



NOTE: Rates of average annual change based on inflation-adjusted currencies.

SOURCE: National Science Foundation/SRS; table C-21

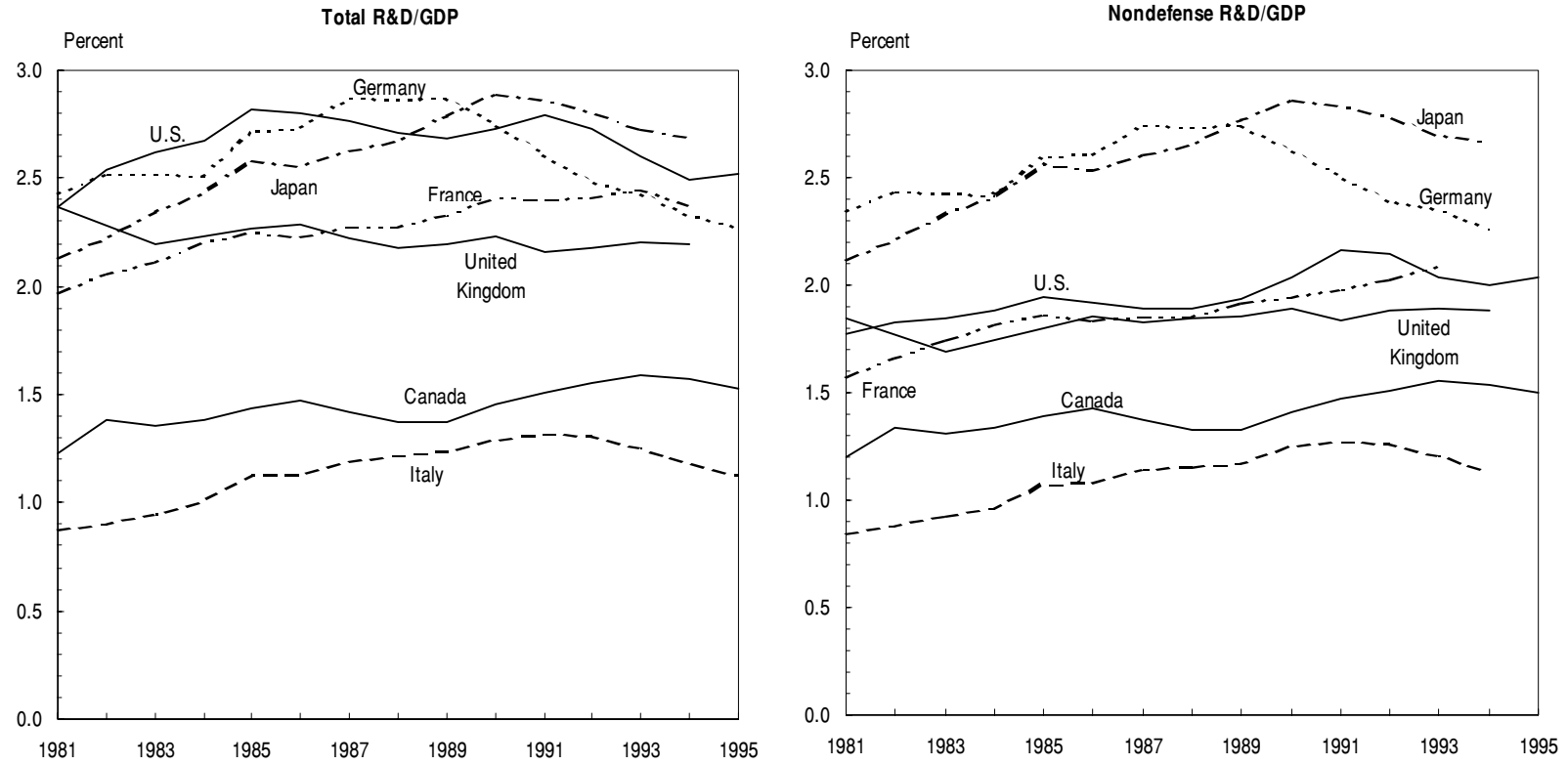
In 1994—the latest year for which foreign data are available—the United States spent 2.49 percent of its GDP on R&D. In comparison, Japan spent 2.69 percent of its GDP; France, 2.38 percent; Germany, 2.33 percent; the United Kingdom, 2.19 percent; Canada, 1.57 percent; and Italy, 1.19 percent.

During the early to mid-1960s, the United States ranked highest among these countries in terms of R&D/GDP ratio. After 1964, however, the U.S. ratio began to decline, as Federal R&D spending for defense and space was cut back and the U.S. GDP continued to increase. At the same time, the ratios of other countries—notably (West) Germany and Japan—slowly increased. These trends continued until the late 1970s, when the U.S. ratio had dropped to 2.2 percent and was roughly equal to those of (West) Germany, the United Kingdom, and Japan.

From the late 1970s through the early 1980s, the ratios in all of the industrialized countries just mentioned, with the exception of the United Kingdom, were again increasing. By 1985, they had reached 2.82 percent for the United States, 2.72 percent for (West) Germany, 2.58 percent for Japan, 2.27 percent for the United Kingdom, and 2.25 percent for France (appendix table C-21). These ratios have fluctuated within narrow ranges since 1985. Japan's ratio peaked at 2.89 percent in 1990 and then dipped back to 2.69 percent in 1994 (chart 9). The ratio for Germany peaked at 2.88 percent in 1987 but has since declined to 2.33 percent in 1994—a result, in part, of the reunification of Germany and its subsequent effects on official statistics. The R&D/GDP ratio for France rose continually from 1.97 percent in 1981 to 2.45 percent in 1993, but in 1994 fell to 2.38 percent. The United Kingdom's ratio remained between 2.16 and 2.29 during the period 1983-94. As previously noted, the U.S. ratio fell continually after a peak of 2.82 percent in 1985, as a result of declining defense R&D funding (appendix tables C-21 and C-22).

The separation of R&D into defense and nondefense components allows for an examination of the ratio of nondefense R&D to total GDP. In 1994, the most recent year for complete data, the United States had a

Chart 9. R&D expenditures as a percentage of GDP, by country: 1981-95



SOURCE: National Science Foundation/SRS; tables C-21 and C-22

nondefense R&D/GDP of 2.0 percent. Compared with the industrialized countries under discussion, the United States ranks fourth in terms of nondefense R&D/GDP , below Japan (2.7 percent), Germany (2.3 percent), and France (2.1 percent),[15] but above the United Kingdom (1.9 percent), Canada (1.5 percent), and Italy (1.1 percent) (chart 9). Roughly 80 percent of the U.S. R&D effort in 1994 was devoted to nondefense activities, as compared with 99 percent for Japan.

R&D Scientists and Engineers/ Labor Force Ratios

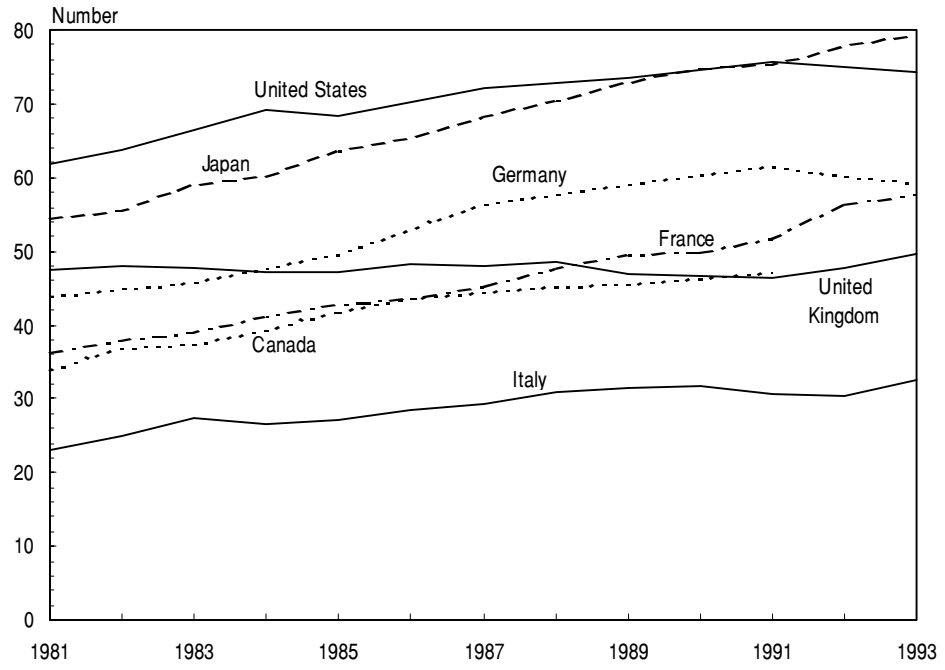
Another useful measure for international comparisons is the number of R&D scientists and engineers in a country as a proportion of its total labor force. The estimated number of scientists and engineers employed in full-time-equivalent (FTE) R&D jobs as a proportion of the total labor force is higher in the United States and Japan than in the other industrialized market economies under discussion. For the United States, FTE R&D scientists and engineers has tended to rise steadily—with minor fluctuations—from approximately 0.55 percent of the labor force in 1976 to 0.76 percent in 1991. However, in 1993, the most recent year for which complete data are available, the number fell slightly to 0.74 percent, or 74 S&Es per 10,000 labor force (chart 10).

In 1993, for the first time in recent history, Japan exceeded the United States in the proportion of all employees that are R&D S&Es—0.80 percent in Japan compared to 0.74 percent in the United States. This difference in the R&D S&E ratio between the United States and Japan is in sharp contrast to earlier values. For example, in 1981, the proportions were 0.62 for the United States and 0.55 for Japan.[16] France and Germany also experienced significant increases in this proportion between 1981 and 1993: from 0.36 percent to 0.58 percent, and from 0.44 percent to 0.59 percent, respectively. In Canada, R&D S&Es increased from 0.34 percent of the labor force in 1981 to 0.47 percent in 1991. In contrast, the United Kingdom and Italy show relatively smaller growth in this percentage. Overall, U.S. leadership in terms of the highest proportion of R&D S&Es in the labor force no longer holds, and is continuing to deteriorate in relation to other industrialized nations.

[15] For France, the 1993 ratio is cited, as the 1994 figure was not yet available.

[16] Japanese and U.S. surveys on the number of scientists and engineers engaged in R&D are not strictly comparable. Estimates for most of the U.S. data are adjusted to capture full-time equivalence; Japanese surveys, on the other hand, ask for the total number of S&Es engaged in R&D regardless of the amount of time devoted to R&D. Japanese data on scientists and engineers exclude those engaged in R&D in the social sciences. The U.S. data exclude such personnel from the industry sector alone. The historical series for these U.S. personnel data was revised in this *National Patterns.* Data for 1985 and later years are not directly comparable with the data for 1984 and earlier years. See appendix A for a review of these changes.

Chart 10. Scientists and engineers engaged in R&D per 10,000 labor force, by country: 1981-93



SOURCE: National Science Foundation/SRS; table C-20

National R&D Performance Patterns—by Sector

The sectoral shares of U.S. R&D performance, measured in terms of expenditures, have shifted slightly during the past decade. In 1980, industry performed 71 percent of the Nation's R&D; the academic sector—including FFRDCs administered by universities—accounted for 13 percent; the Federal Government, 12 percent; and the nonprofit sector, 3 percent. As industry's defense-related R&D efforts accelerated in the early 1980s, its share of the performance total rose to a 1985 peak of 74 percent. Based on preliminary estimates for 1996, academic R&D performance now represents 12.2 percent of the U.S. total, Federal intramural R&D performance 8.8 percent, other nonprofit organizations 3.3 percent, and private industry 72.8 percent, leaving university-administered FFRDCs with 2.9 percent of the total (table 5).[17]

From 1985 to 1996, R&D performance, in real-dollar expenditures, grew by 1.4 percent per year for all sectors combined, based on preliminary calculations for 1996. This growth was not evenly balanced across sectors: R&D performance at universities and colleges (excluding FFRDCs) grew by 4.8 percent per year in real terms, compared with growth of 2.3 percent per year for nonprofit organizations, 1.3 percent growth for industry, growth of 0.9 percent per year for academic FFRDCs, and a decline of 0.9 percent per year for Federal intramural performance.

Industry

R&D performance by private industry will reach a projected $134.2 billion in 1996, which includes $2.1 billion spent by FFRDCs administered by industrial firms. This total represents a 2.0 percent real increase over the 1995 preliminary total (chart 11). That 1995 total of $128.7 billion in current dollars reflects a much larger real gain of 5.9 percent over the previous year—the largest percentage gain in real industrial R&D performance since 1985.

In 1996, R&D performed by industry that was not federally supported but financed almost entirely by companies themselves is 3.5 percent higher in real terms than its 1995 level, according to preliminary data. Overall, these data imply that private companies will fund approximately 83 percent ($111.0 billion) of their 1996 R&D performance, with the Federal Government funding nearly all the rest ($23 billion, or 17 percent of total). Preliminary figures also indicate a 4.2 percent fall, in real terms, in Federal funds for industrial R&D activities between 1995 and 1996. As recently as 1987, the Federal funding share of industry's performance total was 33 percent; however, this Federal share has been steadily declining since its 1959 peak of 59 percent .

Individual industries show very different R&D performance trends and shares of the industry R&D total since the early 1980s. R&D performance by manufacturers of aircraft and spacecraft/guided missiles manufacturers (Standard Industrial Classification—SIC—codes 372 and 376, respectively) has been the most volatile, representing, for example, 25 percent of total industry R&D performance in 1988, but only 12 percent in 1994 (table 6). These movements can be partially explained by parallel shifts in Federal defense-related funding during the period. Overall, the greatest rates of annual growth in real R&D performance observed recently occurred in SIC code 283, drugs and medicines (9 percent), SIC codes 381-382, scientific and mechanical measuring instruments (20 percent), and "nonmanufacturing industries" (16 percent).[18] In this latter catch-all category, R&D activity is concentrated in nonmanufacturing firms whose primary activity involves communications services and computer-related and engineering services.

[17] The industry and nonprofit sectors' performance totals reported here include R&D performed by FFRDCs administered by organizations in their respective sectors. However, in table C-2, R&D expenditures for these FFRDCs are reported separately.

[18] These rates are based on growth between 1984 and 1994, or between years within that interval for which data were available. The growth rate of R&D performance for drugs and medicines was based on a comparison of 1986 and 1994 real levels, since data were not available for 1984-85. Similarly, the growth calculation for scientific and mechanical measuring instruments used 1988 and 1994 data. Growth for nonmanufacturing industries was based on 1984 and 1994 levels. (See table C-29 for R&D performance in current dollars, and C-1 for deflators.)

Table 5. Projected levels of intersectoral transfers of funds for performance of R&D: 1996

Character of Work / Sources of Funds	Federal Government	Industry[1]	Universities and colleges	U&C associated FFRDCs[2]	Other nonprofit institutions[1]	Total	Percent distribution by sources
	[millions of current dollars]						
TOTAL R&D							
Federal Government	16,200	23,200	13,400	5,400	3,700	61,900	33.6%
Industry	--	111,000	1,600	--	850	113,450	61.6%
Universities and colleges	--	--	5,800	--	--	5,800	3.1%
Other nonprofit institutions	--	--	1,600	--	1,550	3,150	1.7%
Total	16,200	134,200	22,400	5,400	6,100	184,300	100.0%
Percent distribution, performers	8.8%	72.8%	12.2%	2.9%	3.3%	100.0%	
BASIC RESEARCH							
Federal Government	2,500	900	9,500	3,000	1,250	17,150	57.6%
Industry	--	6,000	1,000	--	390	7,390	24.8%
Universities and colleges	--	--	3,600	--	--	3,600	12.1%
Other nonprofit institutions	--	--	1,000	--	620	1,620	5.4%
Total	2,500	6,900	15,100	3,000	2,260	29,760	100.0%
Percent distribution, performers	8.4%	23.2%	50.7%	10.1%	7.6%	100.0%	
APPLIED RESEARCH							
Federal Government	4,900	4,300	2,850	1,000	1,050	14,100	36.4%
Industry	--	21,000	500	--	290	21,790	56.2%
Universities and colleges	--	--	1,800	--	--	1,800	4.6%
Other nonprofit institutions	--	--	500	--	560	1,060	2.7%
Total	4,900	25,300	5,650	1,000	1,900	38,750	100.0%
Percent distribution, performers	12.6%	65.3%	14.6%	2.6%	4.9%	100.0%	
DEVELOPMENT							
Federal Government	8,800	18,000	1,050	1,400	1,400	30,650	26.5%
Industry	--	84,000	100	--	170	84,270	72.8%
Universities and colleges	--	--	400	--	--	400	0.3%
Other nonprofit institutions	--	--	100	--	370	470	0.4%
Total	8,800	102,000	1,650	1,400	1,940	115,790	100.0%
Percent distribution, performers	7.6%	88.1%	1.4%	1.2%	1.7%	100.0%	

[1] Expenditures for FFRDCs administered by both industry and nonprofit institutions are included in the totals of their respective sectors. They are estimated to account for less than 2 percent and 15 percent, respectively, of the industry and nonprofit institutions performance totals. FFRDCs are organizations exclusively or substantially financed by the Federal Government to meet a particular requirement or to provide major facilities for research and training purposes.

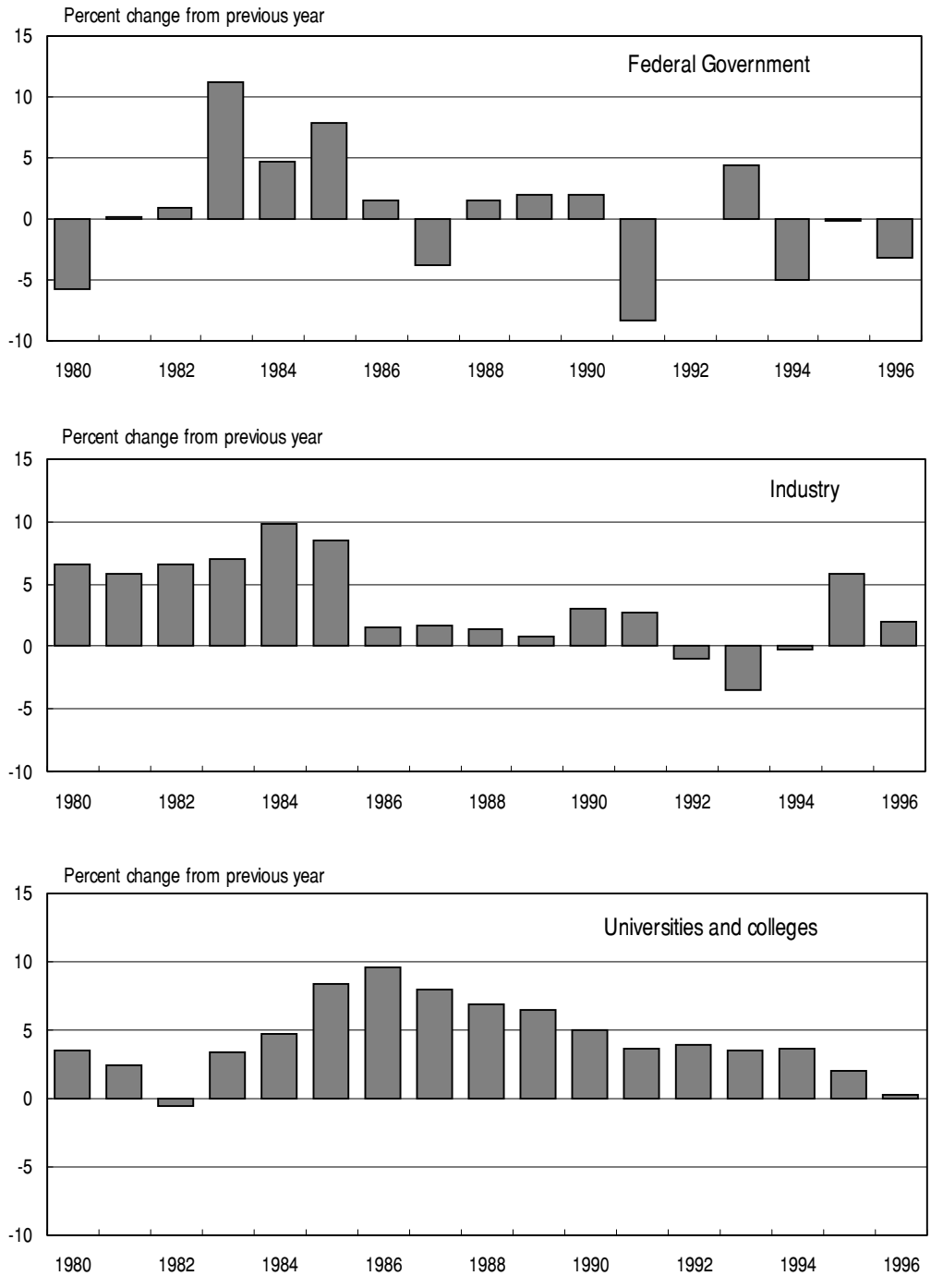
[2] FFRDCs administrered by individual universities and colleges and by university consortia.

KEY: FFRDC = Federally funded research and development center

NOTE: State and local government funds were included in industry funds reported to industry performers, and in university and college funds reported to university and college performers.

SOURCE: National Science Foundation/SRS

Chart 11. Changes in national R&D spending, by performer: 1980-96 (based on constant 1987 dollars)



NOTE: Data are preliminary for 1995 and 1996.

SOURCE: National Science Foundation/SRS; table C-4

Table 6. Total industrial R&D performance, by industry: 1984, 1988, 1992, and 1994

	Year			
	1984	1988	1992	1994
Total Industrial R&D Performance (millions of current dollars).....	74,800	97,015	119,110	119,595
Distribution by Industry	[percent]			
Drugs and medicines (283).....	4	5	7	8
Industrial and other chemicals (28, excluding 283).....	6	6	6	6
Petroleum refining and extraction (13, 29).....	3	2	2	2
Machinery and computers (35).....	14	13	13	7
Electrical equipment (36).....	18	15	11	13
Aircraft and missiles (372, 376).....	25	25	14	12
Other transportation (37, excluding 372, 376).....	10	11	9	12
Professional and sciencfific instruments (38).....	6	6	8	10
Other manufacturing industries.....	7	6	6	6
Nonmanufacturing industries.....	7	11	24	24

NOTES: Numbers in parentheses are SIC codes.
As a result of changes in the underlying survey design, data for 1992 and 1994 are not directly comparable with those for earlier years. See accompanying text and appendix A.

SOURCE: National Science Foundation/SRS, table C-26

A new sample had been selected in 1992 for the underlying industry R&D survey, the first since 1987. As a result, data for 1991 and subsequent years reflect more recent information about the distribution of R&D expenditures across industry groups, the R&D performance of smaller firms, and the R&D performance of firms classified in the nonmanufacturing sector. Shifts in non-federal R&D expenditures reported for 1994 in table 3 reflect the revised information obtained using this new sample. (See appendix A for a more complete discussion of the sample selection.)

Federal financing for specific industries varies considerably. The Federal Government provided $22.5 billion for all industry R&D performance in 1994, the most recent year for which detailed industry-specific data are available by all sources of funds. Aerospace companies, alone, received 39 percent of all Government funds provided to industry. Consequently, 62 percent of the aerospace industry's R&D dollars came from Federal sources, with the remaining 38 percent coming from companies' own funds (chart 12). In comparison, the electrical equipment industry financed 88 percent of its own R&D in 1994; the machinery industry funded 99 percent of its R&D in 1994; and chemical companies—including pharmaceutical firms—funded 98 percent of their R&D in 1992.[19]

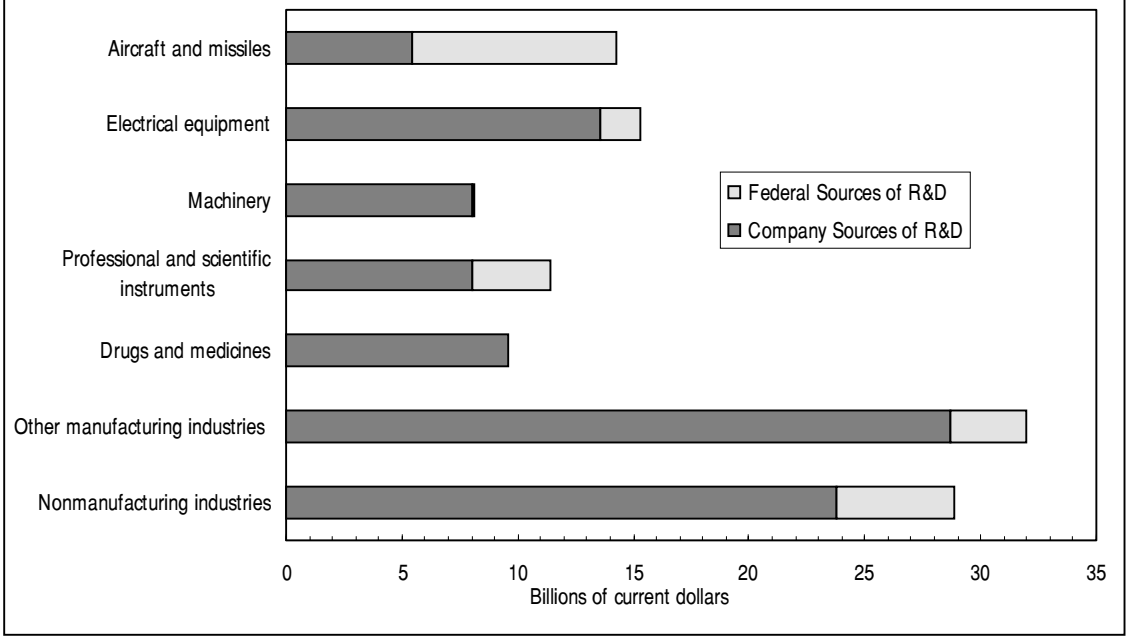
FEDERAL GOVERNMENT

The Federal Government will perform $16.2 billion of the 1996 U.S. R&D total, based on preliminary estimates. This figure is slightly lower than the level estimated for 1995, $16.4 billion, which reflects a real decline of 3.3 percent. Federal agencies account for 8.8 percent of the projected 1996 national R&D performance effort; this continues a gradual decline of Federal funding as a percentage of total R&D, that began in the mid-1970s.

Until 1980, the Federal Government had been the second largest R&D performer in the Nation. Its share of the national R&D performance total, however, fell from 16 percent in 1970 to 12 percent in 1980. This reduction was due primarily to cutbacks in space R&D

[19] The most recent year for which total R&D performance data were available for the industry chemicals and allied products (SIC code 28) was 1992. (See table C-29.)

Chart 12. Industrial R&D performance, by industry and source of funds: 1994



SOURCE: National Science Foundation/SRS; tables C-30 and C-31

programs. NASA funds for intramural R&D performance decreased by more than one-half in real terms during this period. As a result, in 1980, the academic sector—including associated FFRDCs—surpassed the Federal Government in terms of share of national R&D performance.

Preliminary estimates of Federal obligations for intramural research for 1996 are slightly higher than preliminary estimates of intramural performance—$16.29 billion versus $16.20 billion, respectively, in current dollars. Intramural R&D obligations by DOD will decrease in real terms between 1995 and 1996 by 11.8 percent to its projected 1996 level of $7.85 billion (in current dollars). NASA's intramural R&D obligations will decrease as well, by 7.25 percent in real terms, to $2.03 billion (in current dollars); while HHS—whose intramural R&D is mostly obligated to NIH—will rise by approximately 1.1 percent, to $2.35 billion.[20] Together, these three agencies account for 75.0 percent of Federal intramural R&D obligations for 1996 (table 3).

[20] This increase represents the overall effect on intramural R&D obligations for the agency, which takes into account the Social Security Administration (SSA) becoming a separate agency from HHS during FY 1995. That is, the percentage increase reported would be larger—though negligibly—if HHS in 1995 were defined as not including SSA, as it is in 1996.

UNIVERSITIES AND COLLEGES

Universities and colleges (excluding academically administered FFRDCs) are expected to account for 12.2 percent ($22.4 billion) of the 1996 national R&D performance effort. This total implies that there has been virtually no change (less than 0.1 percent increase) between 1995 and 1996 in the amount of real R&D performance carried out at universities and colleges.

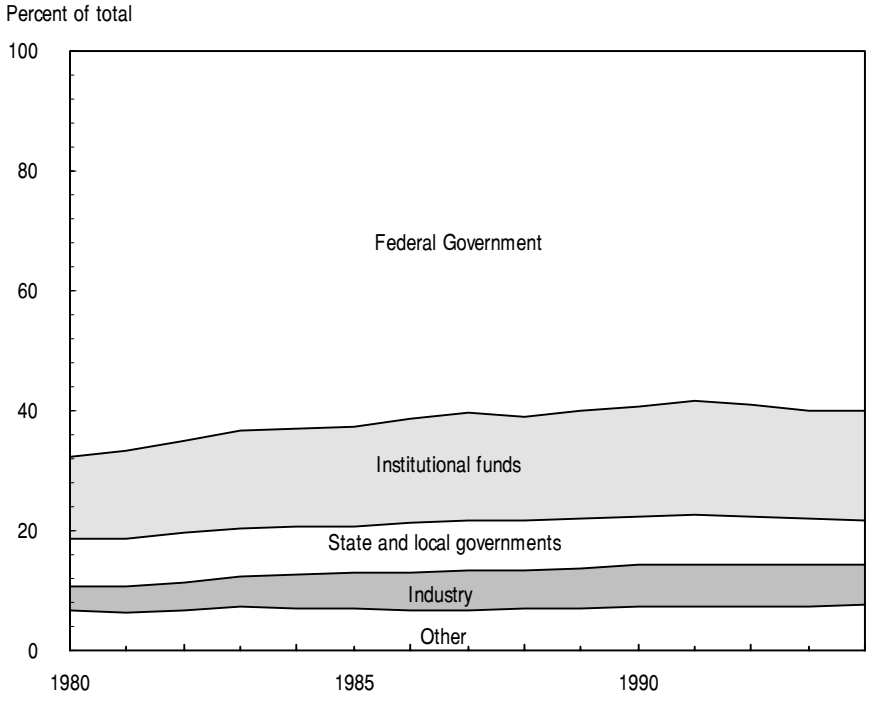
Unlike the industry and Federal sectors, overall R&D performance by the academic sector increased rapidly throughout the mid-1980s and continued to grow, though less rapidly, in the early 1990s (chart 11).[21] From 1980 to 1985, real growth averaged under 4 percent annually. While real increases in the R&D performance of other sectors slowed considerably after 1985, universities and colleges experienced a preliminary 4.8 percent real annual growth rate over the 1985-96 period.

The Federal Government provides the major share of the R&D funds used by universities and colleges. In the early 1980s, Federal funds accounted for two-thirds of the academic total. By 1991, however, this share had dropped to a low of 58 percent; and it has not changed noticeably since then—e.g., the share for 1996 is 60 percent, according to preliminary calculations. Consequently, much of the recent growth in academic R&D performance is attributable to increased funding from non-Federal sources (chart 13).

Between 1985 and 1996, total R&D performance by universities and colleges (excluding FFRDCs) increased by 66.6 percent in real terms, while the academic share of total U.S. R&D performance grew from 8.5 percent to 12.2 percent, by preliminary

[21] R&D data are for separately budgeted expenditures only. Consequently, they exclude that portion of salaries for research time or other research expenses financed by funds not specifically earmarked for R&D from State and local governments and other non-Federal sources, including endowments.

Chart 13. Source of funds for university and college R&D performance: 1980-94



NOTES: State and local government funds exclude general purpose appropriations that universities use at their discretion for R&D. Such funds are included in the institutional funds total.

SOURCE: National Science Foundation/SRS; table C-2

calculations. Federally financed academic R&D, expected to reach $13.4 billion in current dollars in 1996, is up 59.2 percent in real terms from 1985; university and college R&D performance using non-Federal funds, $9.0 billion, is up by 79.0 percent in real terms. The links between academic institutions and industry expanded considerably. Industry's academic R&D funding is expected to increase by 105.9 percent in real terms from 1985 to 1996, although it accounts for just 7.1 percent ($1.6 billion) of academia's expected 1996 R&D total. Universities' own institutional funds—the largest non-Federal source—are, by preliminary calculations, 87.2 percent higher in real terms in 1996 than in 1985 and account for 18.8 percent ($4.2 billion) of their separately budgeted R&D expenditures. Real R&D funds from State and local governments are expected to increase by 53.3 percent over this 11-year period, and constitute 7.1 percent ($1.6 billion) of universities' projected 1996 R&D total.

Academically Administered FFRDCs

R&D performance in 1996 by university-administered FFRDCs is estimated at $5.4 billion, or approximately 2.9 percent of the national R&D performance effort. These FFRDCs account for 19.4 percent of the total 1996 academic (universities and colleges plus academically administered FFRDCs) R&D performance.

The most recent year for data on university R&D expenditures by field of study is 1994 (table C-39). In this year, engineering accounted for 32.1 percent of R&D expenditures at university-administered FFRDCs; the physical sciences (astronomy, chemistry, physics, and related subfields) accounted for 41.5 percent. Within universities and colleges, engineering and the physical sciences represented 15.8 percent and 10.3 percent, respectively, of R&D performance in 1994. Life sciences accounted for 54.7 percent of R&D total at universities and colleges but a considerably smaller share (3.6 percent) of R&D at academically-administered FFRDCs (tables C-37 and C-39).

From 1974 to 1980, academically administered FFRDCs increased their R&D performance by 62.6 percent in real terms. This increase largely mirrored the Federal emphasis on energy programs. Since 1980, the Federal shift from energy to defense has resulted in much slower growth in academically administered FFRDC R&D performance—a 31.6 percent increase in real terms from 1980 to 1996 based on preliminary calculations, or about one-half the growth in more than twice the time.

NATIONAL R&D PERFORMANCE PATTERNS—BY STATE

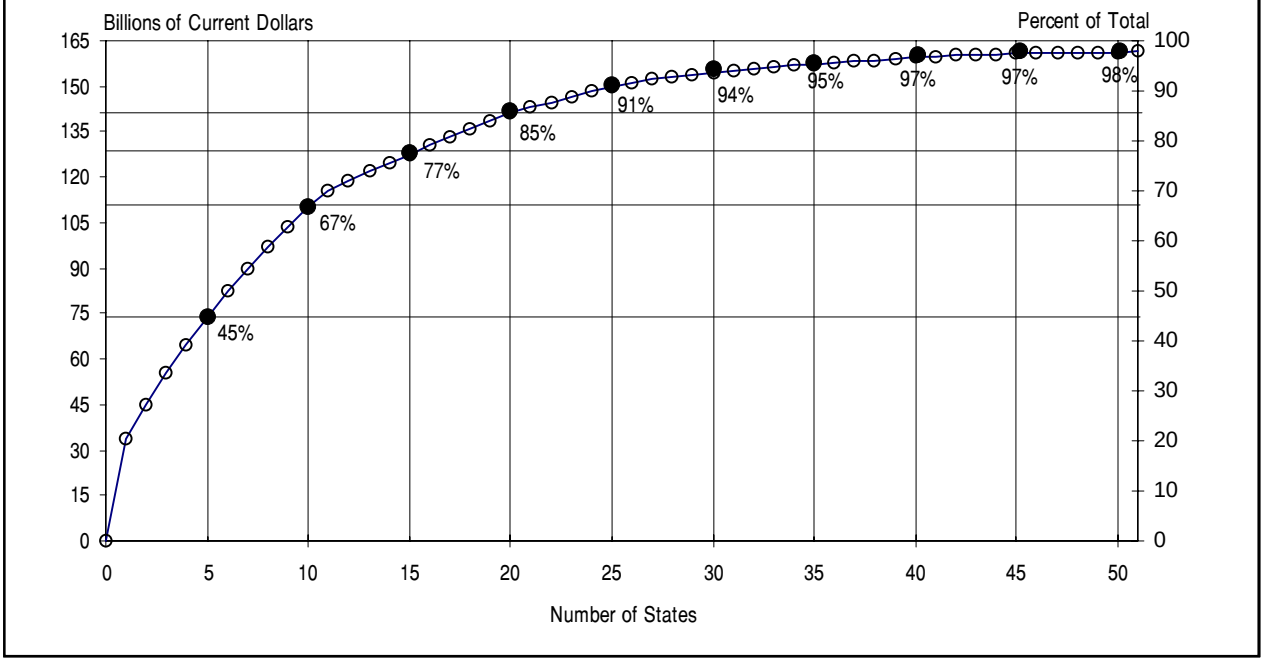
The latest data available on the State distribution of R&D expenditures are for 1993.[22] These data cover R&D performance by industry, academia, and Federal agencies, and the federally funded R&D activities of nonprofit institutions.[23] The State data on R&D contains 52 records: the 50 States; the District of Columbia; and "other/unknown," which accounts for R&D in Puerto Rico and other non-State U.S. regions, as well as R&D for which the particular State in question was not known. Approximately two-thirds of the R&D that could not be associated with a particular state is R&D performed by the nonprofit sector. Consequently, the distribution of R&D by State indicates primarily where R&D is undertaken in Federal, industrial, and university facilities.

The State distribution of R&D performance is highly concentrated (chart 14). The top 25 areas for R&D performance—including the District of Columbia, but excluding "other/unknown," which would be ranked 12th if it were counted—accounted for approximately 91 percent ($150 billion in current dollars) of total U.S. R&D performance in 1993.

[22] Although annual data are available on the location of R&D performance by the academic and Federal sectors, NSF conducts surveys on the State distribution of industrial R&D performance only in odd-numbered years. At this writing, the 1995 industry R&D survey data have not been processed, making 1993 the most recent year for which the State-specific R&D totals can be reported.

[23] R&D performance data include the R&D activities in FFRDCs in each sector of the economy. For a more detailed description of these data, as well as comparisons of 1985 R&D expenditures with other economic measures (for example, population and gross state product), see NSF, *Geographic Patterns: R&D in the United States*, NSF 89-317 (Washington, DC, 1989).

Chart 14. Cumulative distribution of U.S. R&D performance, by State: 1993



NOTES: The District of Columbia is included here as a State. The cumulative sum reaches 97.8%, rather than 100%, due to R&D performance in the other/unknown category (unassignable to a State).

SOURCE: National Science Foundation/SRS; table C-17

Of the total U.S. R&D dollars, approximately one-half (49.9 percent) was spent in six States: California, New York, Michigan, Massachusetts, New Jersey, and Pennsylvania. Such concentration reflects two factors: the size of State economies as measured by GSP, and the intensity of their R&D as a proportion of GSP. For example, New York is ranked second in both R&D performance and in GSP, while it is 19th among all States in intensity of R&D (table C-17). Consequently, New York's high level of R&D can be attributed primarily to its economic size. In contrast, Massachusetts is ranked 11th in GSP, but fourth in total R&D because of a high R&D intensity. New Mexico has the highest R&D intensity, 8.1 percent, which is attributable to the presence of several FFRDCs in the State; however, because of its relatively small economy, the State is ranked 17th in total R&D performance.

Approximately 67 percent of the national R&D effort was performed in 10 States—the preceding list of six together with Maryland, Texas, Illinois, and Ohio. California, the largest R&D performer, accounted for $33.7 billion (in current dollars) in 1993. In each of the other leading States, R&D expenditures ranged between $6 and $11 billion (in current dollars).

The 10 States that ranked highest in 1993 R&D performance were the same States in the top 10 in 1975, although their ranking has shifted somewhat. The highest three (California, New York, and Michigan) have retained their top ranks since 1975. Pennsylvania, fourth in 1975, was sixth in 1993. Texas moved from 10th place to 8th.

As expected, most of the States that are national leaders in total R&D performance are also leading R&D performers in one or more economic sectors (table 7). For example, of the 10 States that led in total 1993 R&D performance:

- Nine also ranked among the top 10 industrial performers, with Maryland absent from the top 10 industrial performers and Washington added.
- Nine also ranked among the top 10 academic performers, which, absent New Jersey, included North Carolina.
- Six also ranked among the top 10 Federal performers—California, Massachusetts, New Jersey, Maryland, Texas, and Ohio; the other four were Virginia, Alabama, Florida and the District of Columbia.

The inclusion of Virginia and the District of Columbia reflects the concentration of Federal facilities and administrative offices within the Washington, D.C., metropolitan area. Major defense- and space-related research activity explains the inclusion of Alabama and Florida in the list of top 10 Federal performers.

Table 7. States leading in R&D performance by sector and R&D as a percentage of gross state product: 1993

		Top 10 States in size of R&D performance, by type of performer				R&D intensity in relation to size of State economy		
Rank	Total R&D (millions of current dollars)	All R&D Performers in the State[1]	Industry	Universities & Colleges[2]	Federal Government[3]	Most R&D Intensive	R&D/GSP (percent)	Gross State Product (billions of current dollars)
1	33,721	California	California	California	Maryland	New Mexico	8.1	$33.8
2	10,974	New York	Michigan	New York	California	Maryland	6.2	120.0
3	10,778	Michigan	New York	Texas	D.C.	D.C.	6.1	41.6
4	9,486	Massachusetts	New Jersey	Maryland	Virginia	Massachusetts	5.7	167.1
5	9,181	New Jersey	Massachusetts	Massachusetts	Alabama	Michigan	5.1	213.4
6	8,278	Pennsylvania	Pennsylvania	Pennsylvania	Florida	Delaware	4.9	25.6
7	7,423	Maryland	Illinois	Illinois	Ohio	California	4.3	786.4
8	6,966	Texas	Ohio	Michigan	New Jersey	Washington	4.2	129.6
9	6,778	Ilinios	Texas	North Carolina	New Mexico	New Jersey	4.0	229.1
10	6,398	Ohio	Washington	Ohio	Texas	Colorado	3.2	88.6

[1] Includes in-state R&D performance of industry, universities, associated federally funded research and development centers (FFRDCs), and Federal agencies and the federally funded R&D performance of nonprofit institutions.

[2] Excludes R&D activities of university-administered FFRDCs located within these states.

[3] Excludes R&D activities of all FFRDCs located within these states.

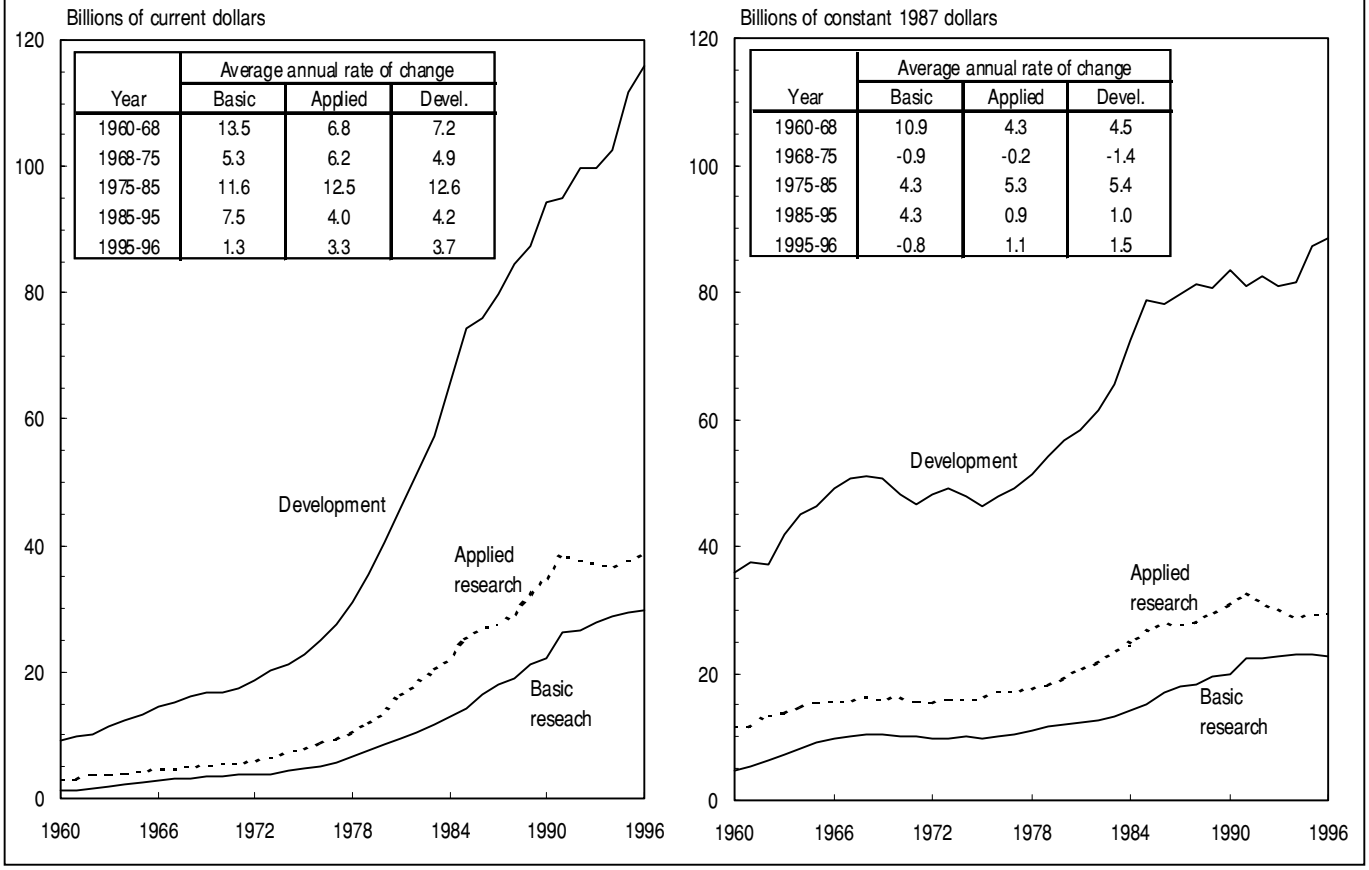
SOURCES: National Science Foundation/SRS, table C-17, and Bureau of Economic Analysis

CHARACTER OF WORK

The Nation will spend an estimated $29.8 billion on basic research in 1996, $38.8 billion on applied research, and $115.8 billion on development (chart 15). These totals represent small changes from preliminary estimates of 1995 levels: a 0.9 percent decrease, in real terms, for basic research; a 1.0 percent increase for applied research; and a 1.5 percent increase for development. As a share of all 1996 projected R&D performance expenditures, basic research represents 16 percent, applied research 21 percent, and development 63 percent.

The expected 1996 percentage shares differ from those reported in earlier periods. For example, in 1980 basic research accounted for 13 percent, applied research for 22 percent, and development for 65 percent. The methodology for imputing character-of-work estimates for industry's R&D performance, however, was changed for 1986 and later years. Consequently, data after 1985 are not strictly comparable with data for 1985 and earlier years. The revised approach resulted in relatively higher estimates for basic and applied research and lower estimates for development expenditures. Furthermore, the improved sampling of industry's R&D activity beginning in 1992 also resulted in notably higher basic research estimates than had previously been presented. (See appendix A for further details.)

Chart 15. National R&D spending, by character of work: 1960-96



Year	Average annual rate of change		
	Basic	Applied	Devel.
1960-68	13.5	6.8	7.2
1968-75	5.3	6.2	4.9
1975-85	11.6	12.5	12.6
1985-95	7.5	4.0	4.2
1995-96	1.3	3.3	3.7

Year	Average annual rate of change		
	Basic	Applied	Devel.
1960-68	10.9	4.3	4.5
1968-75	-0.9	-0.2	-1.4
1975-85	4.3	5.3	5.4
1985-95	4.3	0.9	1.0
1995-96	-0.8	1.1	1.5

NOTES: Imputation methodology was changed for industry after 1985, See appendix A. Data are preliminary for 1995 and 1996.

SOURCE: National Science Foundation/SRS; tables C-6, C-9, and C-12

Basic Research

By preliminary calculations, the average annual real growth in basic research performance between 1986 and 1996 was 2.9 percent, in contrast with 4.8 percent real annual growth between 1980 and 1985.

In terms of support, the Federal Government provided the majority of funds used for basic research. However, the Federal share of funding for basic research dropped as a proportion of all funding—from 70 percent in 1980 to a preliminary 58 percent ($17.2 billion in current dollars) in 1996. This decline does not reflect a diminution in Federal funding for basic research (in fact, it rose an estimated 57 percent in real terms between 1980 and 1996), but instead reflects the growing tendency for such funding to come from other sectors (up 173 percent over the 16-year period).

With regard to performance, universities and colleges account for the largest share (51 percent) of the projected basic research total for 1996. When the performance of university-administered FFRDCs is included, the academic sector's share of total climbs to 61 percent. In 1996, basic research performance of universities—excluding FFRDCs—will reach an estimated $15.1 billion in current dollars, representing a 0.8 percent increase from 1995 in real terms. The Federal Government is expected to provide a preliminary 63 percent of the basic research funds used by the academic sector in 1996. Non-Federal sources, including industry and State governments, will provide the remaining 37 percent.

Applied Research

Over the 1986-96 period, national applied research spending grew at an estimated average annual rate of 0.6 percent in real terms. Increases in industrial support are responsible for most of this gain.

Federal support in 1996 accounts for 36.4 percent ($14.1 billion in current dollars) of the Nation's support for applied research. During the 1980s, Federal support for applied research was intentionally deemphasized in favor of support for basic research. Even with the current administration's push to increase its support of generic/precompetitive applied research, preliminary estimates of Federal support in 1996 for applied research are only 82 percent of that for basic research ($14.1 billion in current dollars versus $17.2 billion, respectively).

Performance by industry accounts for 65 percent ($25.3 billion in current dollars) of the 1996 preliminary total for applied research. Non-Federal sources will account for most ($21.0 billion) of these funds; Federal sources will provide the rest ($4.3 billion).

For the Nation's nonindustrial applied research in 1996, preliminary data indicate that most will be performed by universities and colleges ($5.7 billion in current dollars) and by the Federal Government ($4.9 billion). Approximately 24 percent of the projected Federal intramural applied research will be performed by DOD, another 20 percent by HHS, and 8 percent by NASA.[24] Total Federal applied research performance has been remarkably level over the past 30 years, experiencing only 0.3 percent average annual growth in real terms since 1966.

Development

The Nation's annual funding for development has changed little since the mid-1980s. From 1980 to 1985, development grew, on average, by 6.8 percent per year in real terms as increasingly larger shares of the national R&D effort were directed toward defense R&D, which tends to be approximately 90 percent development. Between 1986 and 1996, development performance in real terms grew at an average annual rate of 1.2 percent, climbing from, in constant 1987 dollars, $78.3 billion in 1986 to $83.4 billion in 1990; it fell to $80.9 billion in 1991 and 1993 before rising, by preliminary calculations, to $88.4 billion in 1996. Growth in both industry's and the Federal Govern-ment's development funding slowed considerably, the latter reflect-

[24] These percentages were derived from preliminary Federal obligations as reported in NSF, *Federal Funds for Research and Development: Fiscal Years 1994, 1995, and 1996,* NSF 97-302.

ing the fiscal constraints placed on overall defense spending. Of the expected 1996 national funding of development, industry will provide 73 percent and the Federal Government, 26 percent.

In terms of performance, industry will account for 88 percent ($102 billion in current dollars) of the Nation's 1996 development activities. Federal performance will account for 8 percent ($8.8 billion in current dollars).

R&D Scientists and Engineers

NSF sponsors a variety of surveys designed to collect data on the human resources devoted to science and technology in the United States, including information on worker inputs for R&D. Surveys directed at *employers or institutions* focus on the amount of time devoted to the performance and management of R&D. These data are reported in terms of person-years, or full-time-equivalent R&D jobs. Surveys directed at *individuals* collect data on self-reported primary work activity; that is, the activity on which a scientist/engineer spends the largest proportion of time but that is not necessarily full time. The 1994 *National Patterns* was the first to include revised estimates of the total number of scientists and engineers engaged primarily in R&D activities. The national totals include an FTE count of S&Es employed by industry, the total number of Federal employees whose primary work activity is research or development, an FTE estimate of graduate students' research activity, and the number of doctorate-holding S&Es working in educational or nonprofit organizations who self-report their primary work activity as research, development, or (up to 1993) the management of R&D work. These concepts are further described in appendix A.

National Estimates of R&D Scientists and Engineers

Approximately 962,700 scientists and engineers were employed in 1993 on R&D activities in the United States (table C-18). This figure reflects virtually no change (a 0.2 percent increase) from the 1991 level of 960,400. It reflects only a 20.1 percent increase over the 1985 figure of 801,900, the first year for which revised national tabulations are derived.[25] In 1993, industry employed 79.4 percent of these R&D personnel. Companies classified under nonmanufac-turing industries accounted for the single largest industry share—25.3 percent of the industry total of 764,500 S&Es. This stands in sharp contrast to only 6 years earlier, 1987, when the transportation equipment industry was the largest employer of industry R&D scientists and engineers, and had nearly twice as many R&D S&Es as nonmanufacturing (187,800 versus 99,200, respectively). The Federal Government employed 6.2 percent (60,000) of the Nation's R&D S&Es in 1993, while the academic and nonprofit sectors accounted for the rest. Although the sector-specific survey methodologies differ considerably, the data indicate that a much higher percentage of Federal R&D S&Es in 1993 were employed in development activities (58.2 percent) than the percentage of academic R&D S&Es holding doctorates (3.2 percent).

In 1981, the number of scientists and engineers engaged in R&D per 10,000 labor force was just under 62 (table C-20). This ratio climbed continually through the 1980s, reached a peak of 75.7 per 10,000 in 1991, and dropped slightly to the most recent reported level of 74.3 per 10,000 in 1993.

In 1993, the Nation spent an average of approximately $139,000 (constant 1987 dollars) on R&D per R&D scientist and engineer; this includes salaries, fringe benefits, materials, supplies, and overhead for R&D activities. The comparable figure for 1985 was about $150,000 (constant 1987 dollars). (See table C-36 for industry-specific ratios.)

Surveys of Doctoral Scientists and Engineers

In 1993, the latest year for available data, there were approximately 462,870 doctoral scientists and engineers employed in the United States (table C-19). This total represents a 34.6 percent increase over the 344,000 reported for 1981. Holders of doctorates in sciences greatly outnumbered holders of doctorates in engineering—388,000 versus 75,000—with the number for sciences including 137,000 under "social and related sciences."

Forty-one percent of all science and engineering doctorate-holders reported R&D as their primary work activity in 1993. Basic research as a primary activity accounted for 14 percent of all scientists and engineers holding doctorates; applied research accounted for 20

[25] See appendix A for details on the FTE R&D scientists and engineers series.

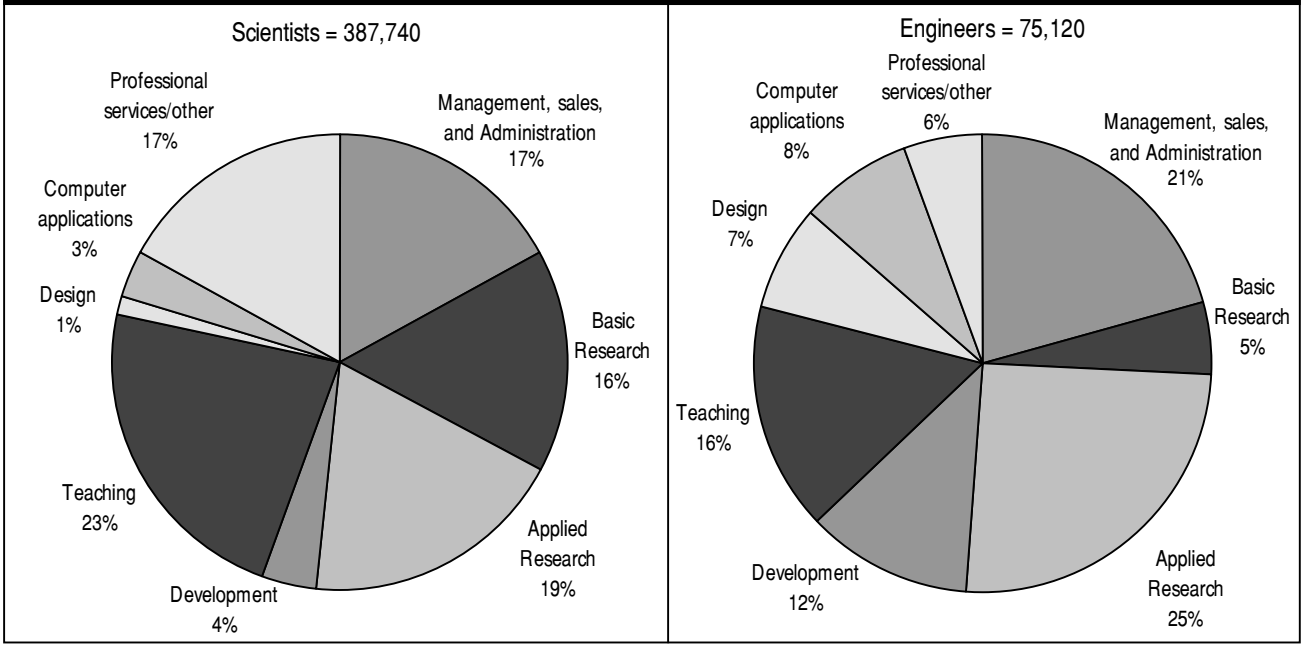
percent; development, 5 percent; and design 2.3 percent.[26] Teaching as a primary activity accounted for 22 percent of doctoral scientists and engineers; the remaining 37 percent were distributed among management/sales/administration (18 percent), computer applications (4 percent), and other professional services (15 percent).

Scientists holding doctorates in 1993 were more likely to have basic research as their primary activity (16 percent) than engineers holding doctorates (5 percent). Consequently, scientists holding doctorates were less likely than engineers to have applied research, development, or design as their primary activity. The respective proportions for doctoral scientists and engineers with regard to these primary activities were 19 percent versus 25 percent for applied research; 4 percent versus 12 percent for development; and 1.3 percent versus 7 percent for design.

Doctoral engineers reported more involvement in management, sales, and administration as a primary work activity (21 percent) than doctoral scientists (17 percent). In contrast, scientists reported more involvement in teaching than engineers—23 percent versus 16 percent (chart 16).

[26] The category of R&D called "design" here refers to an engineering activity—e.g., the design of equipment, processes, structures, and prototype models—rather than a managerial activity—e.g., the design of a research program.

Chart 16. Employed doctoral scientists and engineers, by primary work activity: 1993



SOURCE: National Science Foundation/SRS; table C-19